

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

aTC424
.M4M3
v.3

WASHINGTON ADVISORY COMMITTEE DRAFT
MASSACHUSETTS WATER RESOURCES STUDY

CENTRAL REGION REPORT
MASSACHUSETTS

Prepared by
United States Department of Agriculture
and the
Massachusetts Water Resources Commission

FEBRUARY 1978

Volume 3

NATIONAL

A
G
R
I
C
U
L
T
U
R
A
L

LIBRARY



The United States De
Massachusetts Water
the water and relate
report presents the
consists of the Mer
Areas.

eration with the
pating in a study of
onwealth. This
tral Region which
ne, and Thames Study

Major items for th... are inven-
tories of potential and existing reservoir sites and an inventory of
present land use.

Objectives of this report are to identify problems, needs and alterna-
tive solutions in the following major resource areas: land use, flooding,
erosion and sediment, and wetlands.

The primary purpose of this report prepared by the Soil Conservation
Service, Economic Research Service, and Forest Service is for use by the
Massachusetts Water Resources Commission in the preparation of a comprehen-
sive plan for the Commonwealth's water and land resources. The information
and data contained herein will also assist local, state, and federal
agencies in their specific planning activities for the coordinated and
orderly conservation, development, utilization, and management of the
water and land resources of Massachusetts.

MASSACHUSETTS WATER RESOURCES STUDY
CENTRAL REGION REPORT

TABLE OF CONTENTS

	<u>Page</u>
Preface	i
Chapter 1 - SUMMARY	
1.1 Introduction	1-1
1.2 Findings of This Study	1-3
A Land Use	1-3
B Inland Flooding	1-4
C Erosion and Sediment	1-5
D Wetlands	1-5
E Water Supply and Irrigation	1-5
F Water Quality	1-6
G Recreation	1-6
1.3 Summary	1-6
Chapter 2 - INTRODUCTION	
2.1 General	2-1
2.2 Authority for USDA and Others' Participation	2-1
2.3 Objectives and Nature of Study	2-1
2.4 Planning Procedures and Report Presentation	2-2
2.5 General Description of the Study Area	2-4
2.6 Population	2-5
2.7 Economic Activity	2-7
Chapter 3 - PROBLEMS AND OBJECTIVES	
3.1 Introduction - Principles and Standards	3-1
3.2 Problems and Objectives	3-2

U.S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
JUN 22 1963
CATALOGING - PREP.

	<u>Page</u>
Chapter 4 - ECONOMIC PROJECTIONS AND ENVIRONMENTAL CONSIDERATIONS	
4.1 Historical Development	4-1
4.2 Socio-Economic Data	4-3
A Population	4-3
B Employment	4-3
C Income	4-4
D Urban Centers and Their Influences	4-5
E Transportation	4-5
4.3 Agricultural Resources and Related Economic Activity	4-6
A Major Crop and Livestock Enterprises	4-6
B Employment and Income	4-7
C Economic Factors Affecting Agriculture	4-9
4.4 Forest Resource and Related Economic Activity	4-11
A Extent and Nature of the Resource	4-11
B Utilization	4-13
C Cut and Current Growth	4-14
D Employment & Income in Primary & Secondary Wood Processing	4-15
E Economic Factors Effecting Forest Resource	4-16
4.5 Tourism and Related Economic Situation	4-16
4.6 Relationship Between Economic Situations and NED Specific Components	4-18
A Land Use	4-18
B Flooding	4-19
C Wetlands	4-19
D Recreation	4-19
4.7 Environmental Situation	4-20
A General Description of Topography	4-20
B Coastline and Tidewater	4-20
C Wetlands	4-21
D Inland Water	4-22
E Forest	4-23
F Population Distribution and Land Use Aspects	4-23
4.8 Projections	4-25
A Methodology	4-25
B Population and Economic Projections	4-30
C Land Use Projections	4-34

	<u>Page</u>
Chapter 5 - RESOURCE BASE AND EXISTING PROGRAMS	
5.1 Resource Base	5-1
A General	5-1
B Soils of the Central Region	5-2
C Geology	5-6
D Vegetative Cover	5-8
E Climate	5-8
F Storms and Droughts	5-8
5.2 Land Use	5-9
A Agricultural Land	5-9
B Agricultural Land Study	5-21
C Forestland	5-33
5.3 Inland Flooding	5-35
5.4 Erosion and Sediment	5-41
5.5 Wetlands	5-53
5.6 Water Supply	5-65
5.7 Irrigation	5-65
5.8 Drainage	5-67
5.9 Water Quality	5-67
5.10 Fish and Wildlife	5-78
A Fish	5-78
B Outstanding Fishery Resources	5-80
C Wildlife	5-81
D Value and Use of Wildlife Resources	5-82
E Land Uses and Vegetative Cover	5-85
F Outstanding Wildlife Resources	5-92
5.11 Recreation	5-93
5.12 Existing Programs	5-104
Chapter 6 - FUTURE-WITHOUT-PLAN CONDITION	
6.1 Definition and Use	6-1
6.2 Implications of Economic and Social Projections to Environmental Considerations	6-1
6.3 Description of Future-Without-Plan Condition	6-2
A Agricultural Land	6-2
B Forestland	6-3
C Inland Flooding	6-5
D Erosion and Sediment	6-6
E Wetlands	6-6
F Water Supply	6-9
G Water Quality	6-10
H Recreation	6-11
I Fish and Wildlife	6-13

	<u>Page</u>
Chapter 7 - NEEDS	
7.1 Introduction	7-1
7.2 Land Use Needs	7-1
A Agricultural Land	7-1
B Forestland	7-2
7.3 Flooding	7-4
7.4 Erosion and Sediment	7-5
A Areas Undergoing Urban Development (construction sites)	7-5
B Tilled Cropland	7-5
C Critical Erosion Areas	7-5
D Streambanks	7-6
7.5 Wetlands	7-6
7.6 Water Supply	7-6
7.7 Water Quality	7-7
7.8 Recreation	7-7
Chapter 8 - ALTERNATIVES	8-1
8.1 Introduction	8-1
8.2 Land Use Alternatives	8-1
A Agricultural Land Use Alternatives	8-1
B Forestland	8-4
8.3 Flooding Alternatives	8-5
A Regulatory Measures	8-5
B Corrective Measures	8-6
C Evaluated Alternatives	8-8
8.4 Sediment and Erosion Alternatives	8-10
A Construction Areas	8-10
B Streambank Erosion	8-11
C Tilled Cropland	8-11
8.5 Wetlands	8-13
A Public Acquisition	8-13
B Inland Wetlands Restriction Act	8-15
C Protective Zoning	8-15
8.6 Water Supply Alternatives	8-15
8.7 Water Quality Alternatives	8-16
8.8 Recreation	8-17
8.9 Comparison of Alternatives and Needs	8-17
8.10 Alternative Accounts Display	8-22
8.11 Potential Environmental Impacts of Alternatives	8-22

	<u>Page</u>
Chapter 9 - PROGRAM IMPLEMENTATION OF ALTERNATIVES	
9.1 Introduction	9-1
9.2 Opportunities for USDA Programs	9-1
A Soil Conservation Service Programs	9-1
B Forest Service Programs	9-5
C Farmers Home Administration Loans and Grants	9-5
D Agricultural Stabilization and Conservation Service (ASCS)	9-6
9.3 Opportunities for Other Programs	9-6
A Federal Programs	9-7
B State Programs	9-7
C Regional Programs	9-9

LIST OF APPENDICES

Appendix A Prime Potential Reservoir Sites
Appendix B Wetland Evaluation Criteria
Appendix C List of Ponds, Lakes and Reservoirs (will be furnished later)
Appendix D References (will be furnished later)

CHAPTER 1

SUMMARY

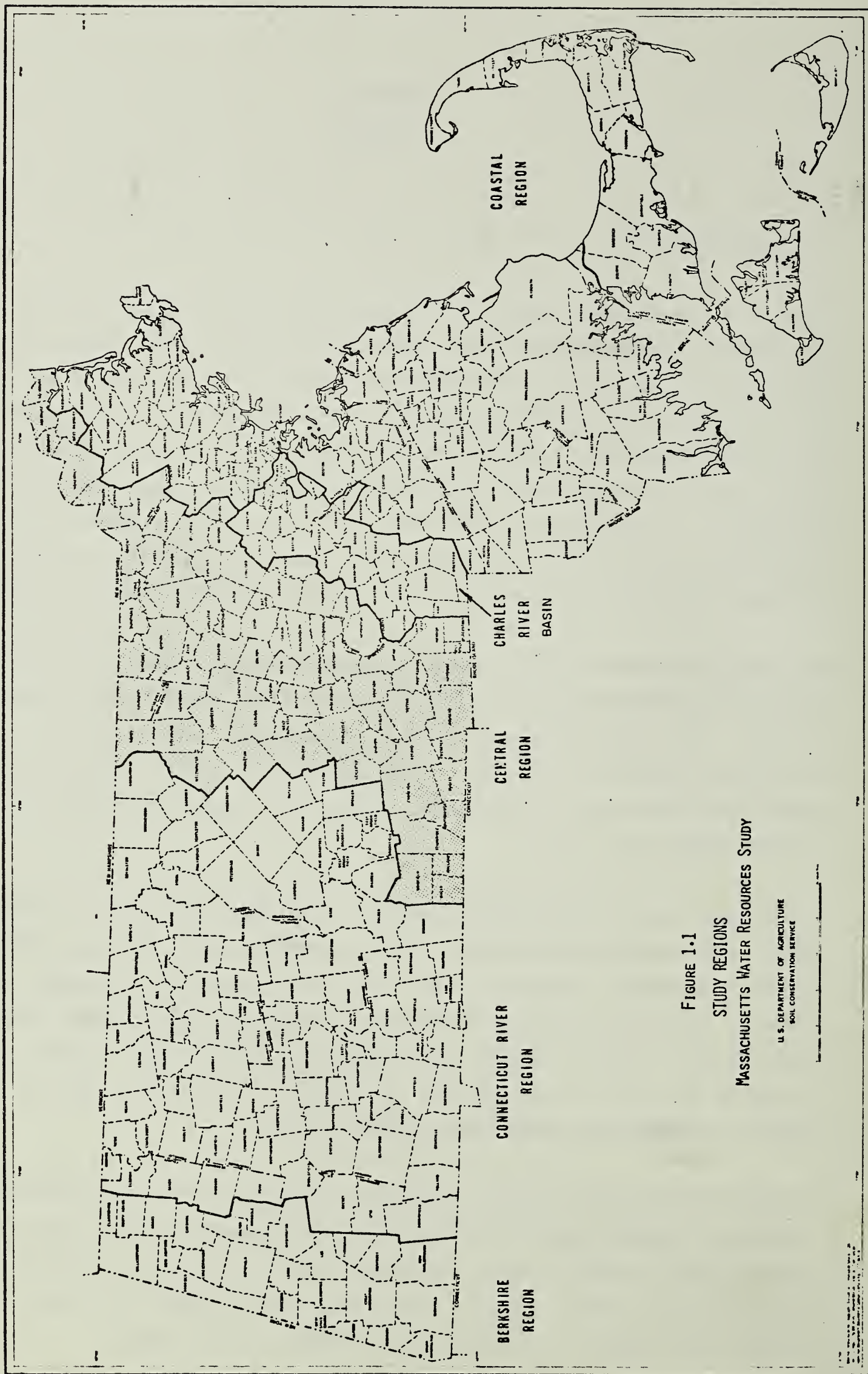
1.1 INTRODUCTION

This is a report of a study, of the water and related land resources of the region, prepared by the U.S. Department of Agriculture (USDA) and the Massachusetts Water Resources Commission. There will be similar reports for the other regions of Massachusetts. The objectives of this study are to identify problems, determine needs through 1990, and suggest alternatives which can be used by the Massachusetts Water Resources Commission to prepare a comprehensive state water and related land resources plan. Information contained in this report will be useful to state, regional, and local agencies concerned with land use and natural resource planning.

For the purposes of the Massachusetts Water Resources Study, the state was divided into four regions: Berkshire, Connecticut River, Central, and Coastal. The Charles River Basin was not included, since studies in that area were completed in 1972 in a cooperative Charles River Implementation Study, with the Corps of Engineers. Figure 1.1 shows the location of the regions within the state.

The Central Region covers approximately 1,700 square miles and includes parts of three major watersheds: the Merrimack, the Blackstone, and the Thames. The major streams are the: Merrimack, Shawsheen, Assabet, Concord, Sudbury, Squanacook, Nashua, Stillwater, Quinapoxet, Blackstone, Mill, Quinsigamond, Mumford, Kettle Brook, Quinebaug, and French. There are 79 cities and towns in the region. A listing of cities and towns by study area is in Chapter 5, Table 5.20 (Wetland Areas).

The Soil Conservation Service, Economics, Statistics and Cooperative Service and Forest Service, are the United States Department of Agriculture agencies participating in this study. The Massachusetts Divisions of Water Resources, Fisheries and Wildlife, Forests and Parks, and the Water Pollution Control are the state agencies most actively involved in this study.



1.2 FINDINGS OF THIS STUDY

1.2A Land Use

In 1975 there were approximately 1,255,000 people in the region. The population is expected to increase 18.4 percent to about 1,485,200 people by 1990.

Forest is the dominant land use in the Central Region covering approximately 61 percent of the land area or 664,505 acres. Over 17 percent of the land is in urban uses with only 9.4 percent in agricultural use. Wetlands, water, and "other" land uses makes up the balance.

During the 20-year period between 1952 and 1972, significant changes in land use have occurred. Agricultural land decreased by 50 percent (100,000 acres) while urban land increased over 139 percent (108,474 acres). Projections of trends in agricultural land suggest that total land in farms will decrease between 22,623 and 68,917 acres between 1974 and 1990. Projections also indicate that urban land is expected to increase by 48 percent (89,773 acres) by 1990.

The state as well as the region is experiencing a continuing decrease in the quantity of agricultural land. The loss of suitable farmland soils to other land uses is nearly irreversible. In addition to reducing the land base available for growing food, the loss of farmland results in a deterioration of the visual and aesthetic quality of the environment. Alternatives and remedial measures such as, zoning, purchase of development rights, and acquisition, are suggested which, if implemented, would decrease the loss of agricultural land.

The forest resource provides wood products, water, forage, wildlife, and recreation. Private owners own the majority of the forested land, and much of the land consists of small tracts. A small proportion of forestland is owned for timber production and perhaps only one-half of this land is available

for wood product production. Alternatives to increase wood product production include an increase in technical assistance; increase in forest program funding and forest production incentives; develop diversified markets for low quality wood; increase in information and education programs.

1.2B Inland Flooding

Within the last 50 years many floods have occurred in the region. Major regional floods occurred in 1936, 1938, 1955, and 1968. These floods damaged residences, commercial buildings, industrial plants, farm fields, roads, and bridges. Average annual flood damage in the region exceeds \$4,900,000 and 100-year frequency flood would cause damage in excess of \$80 million.

Flood plain management programs such as flood plain zoning is being adopted by many towns in the region. These programs will minimize flood damage in future developments but will not reduce flood damages to existing developments in flood plains. However, flood insurance can reduce the monetary risk for individuals. Seventy-six towns have joined the National Flood Insurance Program and property owners can now purchase low cost flood insurance. In return for federally-subsidized insurance, towns are required to regulate future construction in flood hazard areas. As a result of the flood insurance program and the growing tendency to adopt flood plain management measures, future flood plain development is expected to be highly restricted. As a consequence, flood damage is not expected to increase significantly.

Because of the many existing developments in flood plains, alternatives to reduce flood damage to an acceptable level in the region are needed. Alternatives are available to significantly reduce flood damage. Three corrective flood plain management techniques were investigated in this study. Floodproofing, structural measures, and a combination of floodproofing and structural measures offer viable alternatives to continued flood damage.

1.2C Erosion and Sediment

The region is blessed with generally less severe erosion and sedimentation problems than much of the rest of the United States. However, these problems cannot be discounted entirely. The annual erosion in the region is nearly 644,000 tons. About 64,000 tons of sediment are delivered to watercourses each year. Erosion from construction sites is the largest source and accounts for over 250,000 tons per year.

Enactment of erosion and sediment control ordinances, stabilization of critical erosion problem areas, and increased emphasis on management and the installation of land treatment measures on tilled cropland are suggested as alternatives to alleviate the erosion and sediment problems.

1.2D Wetlands

The 82,000 acres of inland wetlands and 2,500 acres of saltwater wetlands in the region provide many benefits which include, flood control, wildlife habitat, open space, and water quality protection. The ongoing wetlands programs especially Massachusetts' pioneer wetlands legislation, will go far in protecting wetlands from harmful alteration.

Increased public acquisition of wetlands, acceleration of the Inland Wetlands Restriction Program, and expanded conservancy zoning of wetlands are included in the alternatives.

1.2E Water Supply and Irrigation

Municipal water for the Central Region comes from both ground water and surface sources. It may be supplied by private concerns, municipalities or the Metropolitan District Commission (MDC). Appendix A of this report identifies potential reservoir sites which might fill needs for municipal water supply for individual communities or small regional systems.

Irrigation water used by agriculture represents a very small part of the total water supply and water use in the region. Water supplies for this purpose are expected to be adequate to meet 1990 needs.

1.2F Water Quality

Existing programs and regulations are adequate to enable the region to meet water quality goals. Point sources of pollution have been drastically reduced in the past 5 years and additional progress is expected. Nonpoint sources of water pollution are receiving increased attention under Section 208 of the Water Pollution Control Act Amendments of 1972.

The Nashua River and the Blackstone River were two of the most grossly polluted rivers in Massachusetts. However, with the new and planned sewage treatment facilities in the Nashua River Basin, improvement of water quality has been noted and is expected to continue as the treatment plant construction program nears completion. Similarly with the Blackstone and the other major rivers of the region, water quality improvement is first dependent on adequate treatment of point sources.

1.2G Recreation

Projections in the Statewide Comprehensive Outdoor Recreation Plan indicate that an unmet demand exists now and will exist in 1990 for camping, picnicking, and hiking. Alternatives are presented which will meet some of the needs. These include development of greenways, and implementation of the Massachusetts Scenic and Recreational Rivers Act.

1.3 SUMMARY

Table 1.1 summarizes the major findings, problems, potential solutions and program opportunities determined as a result of this study.

TABLE 1.1

PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
1. Land use	1. Agricultural land acreage has declined 50% from 1952 to 1972 & is projected to decline further.	Develop programs that help maintain agricultural land use. Complete soil surveys.	Identify important farm lands (soils). Soil survey program.	Farm management and farm account work at U. of Mass. Cooperative Extension Service. Chapter 61A of the Mass. General Laws, Chapter 780, Acts of 1977, Chapter 232, Acts of 1977.
	2. Forestland (approximately 61% of the region) is underutilized for production of wood products.	Increase management of public & private land. Increase incentives to landowners. Develop diversified markets. Establish an information and education program.	Resource conservation and development program. Cooperative forest management program. General forestry assistance program.	Chapter 61 and 61A of Mass. General Laws Classification and Taxation of Forestlands and Forest Products. Small Business Administration.
			Harvest improvement program.	
			Forestry incentives program.	
			Sawmill improvement program.	

TABLE 1.1 - cont.

PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
2. Flooding	1. Future urban flood plain development is expected to be highly restricted.	Enroll towns not now in National Flood Insurance Programs.	PL 83-566, Watershed protection & Flood Prevention Act, SCS.	HUD National Flood Insurance Program.
	2. Average annual flood damage to existing development exceeds \$4,900,000.	Implement plans for structural and nonstructural measures.	RC&D Program.	Corps of Engineers' Small Watersheds and Emergency Projects. Ch. 131, Sec. 40A Inland Wetland Restriction Act.
3. Erosion and Sediment	1. Erosion on construction sites is excessive.	Develop erosion and sediment control ordinances at the municipal level.	Conservation Operations Program, SCS.	Technical assistance from Conservation Districts with inputs from Cooperative Extension Service and County Regional Planning Commissions. Gen. Law Ch. 40, Sec. 21, Zoning Act.
	2. Region has some critical erosion problem areas and eroding streambanks.	Develop measures to stabilize critical areas and problem streambanks.	Agricultural Conservation Program, ASCS. RC&D Program, SCS.	
	3. Erosion rates on approximately 20% of tilled cropland are unacceptably high and result in lowered agricultural productivity.	Inventory cropland with serious erosion problems. Establish priorities for technical and financial assistance to assist landowners install practices to reduce erosion losses.	Conservation Operations Program, SCS. Soil & Water Conservation Loans, FmHA Agricultural Conservation Program, ASCS.	Technical assistance from Conservation Districts.

TABLE 1.1 - cont.

PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
4. Wetlands	1. Region has 82,000 acres of inland wetlands which should be protected from harmful alteration.	Accelerate Restrictions and zoning.		Inland Wetlands Restriction Act.
		Acquire 15,700 acres of inland wetlands by 1990.		Financial assistance for cities and towns for acquisition, state - Self-Help Fund, Gen. Laws, Ch. 132A, Sec. 11.
				Federal - USDI - BOR Land and Water Conservation Fund.
		Expand areas of special regulations such as conservancy zoning to include majority of the region's wetlands.	Mass. Natural Resources Technical Team.	Technical assistance from Conservation Districts.
5. Water Supply and Irrigation	1. Additional municipal water supply will be needed by 1990. 2. Little irrigation water use, except for truck crops and dwarf orchards. Existing programs are adequate.	Additional water supply can be developed from groundwater and/or surface water sources.	USDA Farmers Home Administration loans for community water supply systems.	HUD loans and financial assistance for municipal water supply.
		Potential surface water reservoirs indicated in Appendix A.	Resource Conservation and Development Program.	

TABLE 1.1 - cont.

PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
6. Water Quality	1. "Section 208" water quality studies are underway to control point and nonpoint pollution.			
	2. Sediment from land and streambank erosion.	Same potential solutions, needed actions, and program opportunities as listed under Erosion and Sediment (Resource Area 3).		
7. Recreation	1. There are insufficient camping, picnicking, and hiking facilities.	Provide additional camping, picnicking, and hiking facilities.	Small Watershed Program (PL-566). Resource Conservation and Development Program.	USDI - BOR Land and Water Conservation Fund. Mass. - Self-Help Fund, Gen. Laws, Ch. 132A, Sec. 11. Mass. - Public Access Fund, Gen. Laws, Ch. 21, Sec. 17.
	2. Region has numerous unique natural features.	Plan for preservation of scenic rivers and unique natural areas.	Renewable Resources Program (F.S.). Natural Resource Planning Program (SCS).	Nature Conservancy Programs, Trustees of Reservations and Mass. Audubon Society. Mass. Div. of Forests and Parks. Mass. Scenic and Recreational Rivers Program.

CHAPTER 2 INTRODUCTION

2.1 GENERAL

The Massachusetts Water Resources Study was initiated by a cooperative agreement between the U.S. Department of Agriculture (USDA) and the Massachusetts Water Resources Commission (MWRC). This water and related land resources study provides data for the Commission's use in the preparation of an overall State Water and Related Land Resources Plan.

2.2 AUTHORITY FOR USDA AND OTHERS' PARTICIPATION

The USDA participated in this study at the request of the MWRC. Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 83-566, as amended) authorizes such participation by USDA. The Soil Conservation Service, Economic, Statistics, and Cooperative Service, and The Forest Service, are the USDA agencies participating in this study.

Under state law the MWRC has the responsibility to develop an overall plan, and to coordinate federal, state, and other agencies in the water resources field.

The Massachusetts Divisions of Water Resources, Forests and Parks, Fisheries and Wildlife, and the Water Pollution Control are the state agencies most actively involved in this study.

2.3 OBJECTIVES AND NATURE OF STUDY

Water and related land resource planning by federal agencies is guided by the Principles and Standards (P&S) established by the U.S. Water Resources Council. This guide establishes a thorough and organized approach to water and related land resource planning for two broad objectives:

1. National Economic Development (NED)--to enhance national economic development by increasing the value of the nation's output of goods and services and improving national economic efficiency.
2. Environmental Quality (EQ)--to enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

2.4 PLANNING PROCEDURES AND REPORT PRESENTATION

The P&S planning process is designed to produce a recommended plan, while the Massachusetts Water Resources Study planning process stops with the development of alternatives. The selection of a final or recommended plan is the responsibility of the Massachusetts Water Resources Commission.

This study investigated the following resource areas in detail: Land Use, Inland Flooding, Erosion and Sediment, and Wetlands. The resource areas of Water Quality, Water Supply and Irrigation, Drainage, Fish and Wildlife, and Recreation are ordinarily subjects of investigation for a cooperative water resources study. In the Central Region, however, these resource areas have or are being studied in detail by others. To avoid duplication of effort and to permit more time and effort to be expended upon the four areas studied in detail, it was decided to briefly investigate the other areas. In some cases, the data and conclusions from previous studies are reported to maintain continuity. In other instances, it was found that new resource data could be generated in a specific phase of a resource area. The principles which guided the study intensity were:

1. areas that were adequately covered by previous studies would not be restudied, and
2. only resource areas where the expertise of USDA agencies is recognized would be studied in detail.

The Massachusetts Water Resources Study planning process approximates the first four steps of the P&S process which are as follows:

1. specify components of the objectives relevant to the planning setting;
2. evaluate resource capabilities and expected conditions without any plan;

3. formulate alternative plans to achieve varying levels of contributions to the specified components of the objectives;
4. analyze the differences among alternative plans which reflect different emphasis among the specified components of the objectives.

In addition the P&S requires that beneficial and adverse effects of alternatives or plans on National Economic Development and Environmental Quality be displayed. It also suggests that beneficial and adverse effects of alternatives be displayed, where appropriate, for Regional Development and Social Well-Being.

Study results are presented in chapters according to River Basins Memo RB-12 which reflect the P&S suggested planning process. Data findings in each resource area are placed in the appropriate planning chapter, so that the final report enables the reader to follow the step-by-step procedures used to develop the alternatives. The major chapter format is, as follows:

Chapter 1 (Summary) ---- A brief introduction and summary of the findings in this report.

Chapter 2 (Introduction) ---- Outlines the purpose, authority and objectives of the report, along with a general description of the study area. It also acknowledges the assistance and cooperation of others.

Chapter 3 (Problems and Objectives) ---- The resource problems are stated in terms of their effect on the two main objectives: National Economic Development and Environmental Quality.

Chapter 4 (Economic Projections and Environmental Consideration) ---- Projections of social, economic, and natural resources base data are presented, including projections of population, employment, income, urban development, agricultural and forest activity, and other significant social and economic areas. The relationship between the projections and specific components of the National Economic Development objectives are presented. Projections concerning the environmental setting are also contained in this chapter. Effects of population distribution and land use changes on the environment are discussed.

Chapter 5 (Resource Base and Existing Programs) ---- The existing situation is presented in this chapter. Physical data, such as location, size, soils, geology, vegetative cover, climate, and land use are included. Existing conditions in the four major resource areas (flooding, erosion and sediment, wetlands, and land use) are covered in detail. Existing USDA and other programs which are being utilized to meet resource needs are explained in this chapter.

Chapter 6 (Future-Without-Plan Condition) ---- This chapter describes the conditions to be expected in each of the resource areas if no new alternatives are planned and implemented. The effects of presently authorized projects are considered along with the effects of nonaction.

Chapter 7 (Needs) ---- Needs are defined as the difference between conditions expressed in the Economic Projections and Environmental Considerations section and those adequately addressed by ongoing and planned projects described in the Future-Without-Plan Condition Chapter. This chapter quantifies the extent of the problems outlined in the Problems and Objectives Chapter.

Chapter 8 (Alternatives) ---- This chapter presents a number of alternatives designed to fill the needs expressed in the preceding chapter. Displays showing effects of the alternatives on the four P&S accounts (National Economic Development, Environmental Quality, Regional Development, and Social Well-Being) are included. Alternatives and their potential effects on about 20 major environmental indicators will also be examined.

Chapter 9 (Program Implementation of Alternatives) ---- The chapter describes how USDA programs can be used to implement the alternatives expressed in Chapter 8. Opportunities for other state or federal programs are also discussed. If no existing programs are available to implement an alternative, the need for new or revised programs is investigated.

2.5 GENERAL DESCRIPTION OF THE STUDY AREA

For the Massachusetts Water Resources Studies, the state was divided into four regions: Berkshire, Connecticut River, Central, and the Coastal. Reports have been completed for the Berkshire Region, and on the Charles River Basin in the central portion of the Coastal Region.

The Central Region includes all of the Merrimack, Blackstone, and Thames Rivers within Massachusetts. This region is bounded by the Connecticut border to the south, the New Hampshire border to the north, Connecticut River Watershed to the west, and the independent coastal drainages to the east. Only in the northeast where the Merrimack River flows into the Atlantic Ocean does the Central Region have any coastline.

The region includes parts of four counties, Worcester, Middlesex, Essex, and Hampden. Population densities are much lower in this region than found along the coastal areas to the east. Industry and services related enterprises are the principal means of employment.

The region is composed of 79 towns or cities which are divided into five study areas defined on either a watershed or on a natural boundary basis. The five study areas are the Merrimack, SuAsCo, Nashua, Blackstone and Thames, (see Figure 2.1). The SuAsCo and Nashua study areas are upstream tributaries to the Merrimack River. There is one complete Standard Metropolitan Statistical Area (SMSA) (the Worcester-Fitchburg-Leominster complex) and portions of three others (Lowell-Lawrence-Haverhill, Boston, and Providence-Pawtucket-Warwick, Rhode Island) within the region.

Where applicable, data and findings will be presented for each study area and occasionally by SMSA's. In those cases where no improvement will be made, presentations will be for the entire Central Region.

2.6 POPULATION

The 1975 total permanent population of the Central Region was 1,025,076 an increase of 42,339 (3.5 percent) since 1970 and an increase of 220,945 (21.4 percent) since 1960. It is interesting to note, that of the three-city complex comprising the core of the Worcester-Fitchburg-Leominster SMSA, two lost population between 1970 and 1975. The U.S. census figures show that the populations of Lowell, Haverhill and Lawrence have been declining since 1920. Table 2.1 summarizes the permanent population trends by substudy areas.

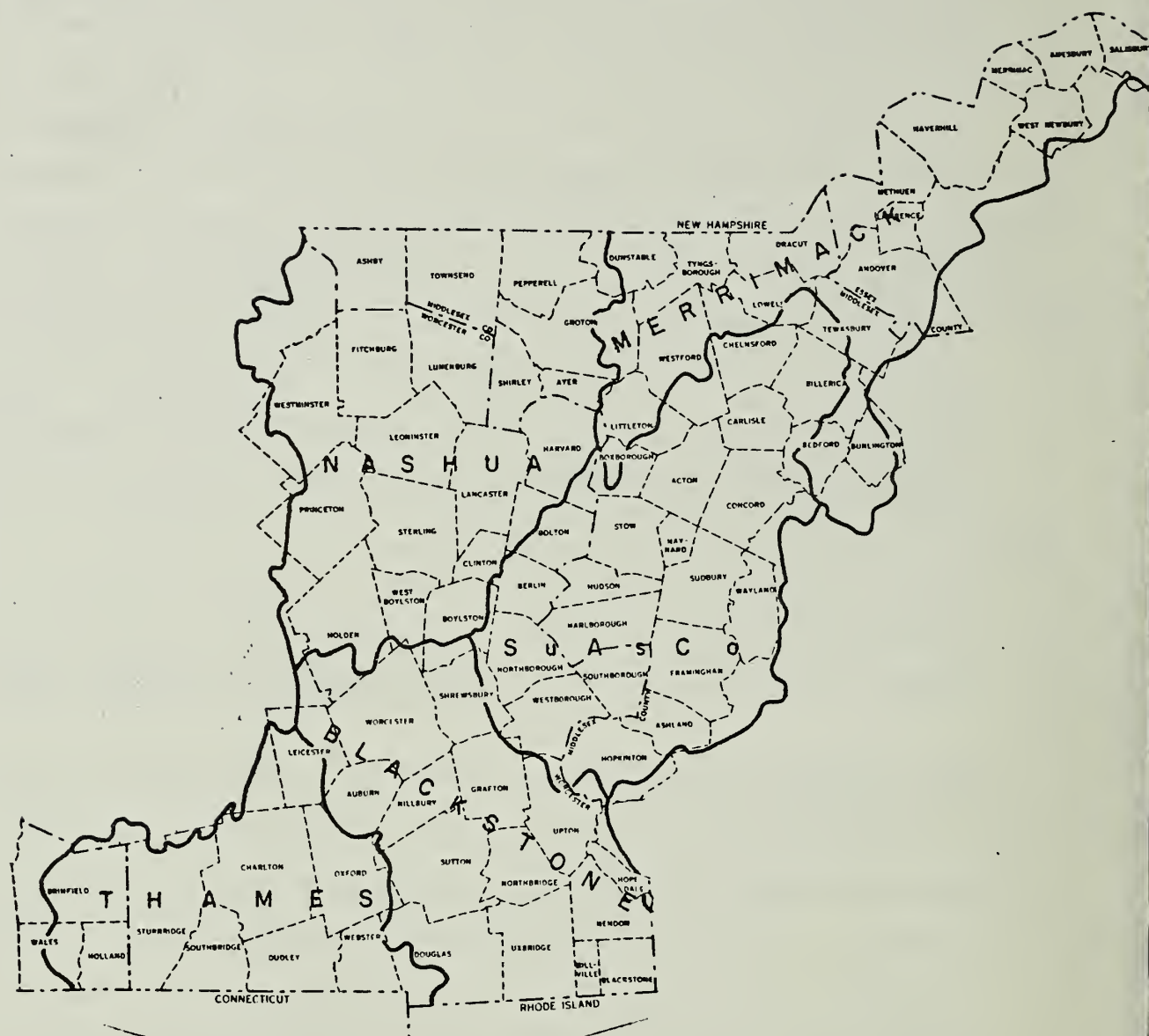


Figure 2.1
Central Region
Towns and Study Areas



TABLE 2.1

Population and Population Changes 1950-1975

	SUBSTUDY					Total Central Reg.
	Merrimack	Nashua	Blackstone	SJAsCo	Thames	
1950	317,947	127,395	266,578	130,662	55,991	898,573
1960	346,734	157,140	261,549	204,613	64,095	1,034,131
1970	405,116	178,334	261,780	294,803	72,704	1,212,737
1975	424,786	174,566	257,397	323,816	74,511	1,255,076
Change 1950-75	106,839	47,171	9,181	193,154	18,520	356,503
% Change 1950-75	33.6	37.03	3.44	147.83	33.08	39.67
Change 1960-75	78,052	17,426	-4,152	119,203	10,416	220,945
% Change 1960-75	22.5	11.90	-1.59	58.26	16.25	21.36
Change 1970-75	19,670	-3,768	-4,383	29,013	1,807	42,339
% Change 1970-75	4.86	-2.11	-1.67	9.84	2.48	3.49

Source: Historical Populations from Town Monographs (op cited) and Regional Planning Commissions in the Central Region.

2.7 ECONOMIC ACTIVITY

Most of the towns and cities in the Central Region were established during the late 1600s and early 1700s with a few towns being established in the early 1800s. Initially, the economic activity in the region centered around a subsistence form of agriculture which was nearly self sufficient. As population and settlement grew, demands for surplus production arose. As agricultural production increased and as newer technologies were adopted to meet the increased demand, labor that was formerly employed in agriculture was freed to work in nonagricultural activities and thus became more specialized.

Typical enterprises included sawmills and grist mills; brick-making factories; cotton and wool mills; paper; tanneries; and boots and shoe factories. Most of the early towns or cities were established on the various rivers in the region primarily because such rivers supplied inexpensive water power. With the advent of steam power in the late 1800s, canals and water transportation were replaced by railroads. Towns were effected either positively or adversely, depending upon the railroad routes.

Presently, manufacturing is the largest employer of any of the various economic and industrial classifications. In 1971 manufacturing employed 49.4 percent of the labor force in the region. Wholesale and retail trade employed 24.2 percent and the service sector employed 12.2 percent. Table 2.2 summarizes the various employments and percentages by substudy areas.

TABLE 2.2 EMPLOYMENT BY SUBSTUDY AREA, 1971

	Merrimack	Nashua	Blackstone	SuAsCo	Thames	Total	Percent of Region 1/ State 2/ National 3/
Agriculture & Mining	350	128	152	471	43	1,144	.7
Construction	5,182	2,214	3,906	4,453	748	16,503	4.9
Manufacturing	49,521	22,425	43,902	40,368	11,193	167,409	49.4
Transportation, Com- munications & Utilities	2,906	1,173	5,711	4,658	465	14,913	4.4
Wholesale & Retail Trade	27,048	9,633	22,581	19,403	3,251	81,916	24.2
Finance, Insurance & Real Estate	4,321	1,141	6,305	2,398	214	14,379	4.2
Service Industrial	15,893	4,469	9,694	9,523	1,589	41,168	12.2
Total 1/	106,262	41,303	92,250	81,310	17,537	338,662	99.6
1970 Population	405,116	178,334	261,780	294,803	72,704	1,212,737	100.
Ratio Employment Total Population %	26.2	23.2	35.2	27.6	24.1	27.91	31.9
							36.0

1/ Individual entries may not sum to 100% due to rounding.

2/ Computed from county business patterns, 1971-72 Massachusetts. USDC Bureau of Sciences.

3/ Computed from 1972 OBERS Projection, Series E Population, Vol. 4 USWRC.

Source: City and Town Monographs, Massachusetts Department of Commerce and Development, Revised 1973.

CHAPTER 3

PROBLEMS AND OBJECTIVES

3.1 INTRODUCTION - PRINCIPLES AND STANDARDS

According to the U.S. Water Resources Council's Principles and Standards for Planning Water and Related Land Resources, the overall purpose of water and land resource planning is to promote the quality of life by reflecting society's preferences for attainment of two major objectives:

1. The enhancement of National Economic Development (NED) by increasing the value of the nation's output of goods and services, and improving national economic efficiency;
2. the enhancement of the Environmental Quality (EQ) by the management, conservation, preservation, location, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The NED objective is attained by measures and actions which result in an increase in the value of goods and services and which improve national economic efficiency. An important component of the NED objective is the value of increased output of goods and services resulting from an action. Water resource alternatives can result in increased production of goods and services which can be measured in terms of increased crop yields, increased recreational use, and reduced flood damages. Increased production from the employment of otherwise unemployed or underemployed resources may also result.

The EQ objective reflects concern for the natural environment and its maintenance and enhancement as a source of enjoyment and a heritage for future generations. Emphasis is given to diverting a portion of the available resources from economic development to achieve environmental goals. As standards of living increase, there is less willingness to accept environmental damage in exchange for economic gain. Specific components of the EQ objective include:

1. creation or improvement of areas of natural beauty and human enjoyment such as open space, wild and scenic rivers, lakes, beaches, and wild areas;
2. management or enhancement of valuable archeological, historical, biological, and geological resources;
3. enhancement of the quality of water, land, and air resources by control and prevention of pollution, erosion, and misuse;
4. caution in meeting development objectives in order to minimize undesirable and possible irreversible changes in the natural environment.

In each of the major water resource areas of concern, problems can be related to one or both of the major national objectives. Flood damages are a good example of a problem which fits into the category of a National Economic Development problem; i.e., flood damage results in a decrease in the value of goods and services which are produced in an area. The problem of regional wetlands loss might logically be classed as both a NED and EQ problem. Loss of wetlands results in loss of wildlife habitat (an EQ loss), as well as decreasing floodwater storage and consequently increasing flood damage downstream (an NED problem).

3.2 PROBLEMS AND OBJECTIVES

Table 3.1 presents problems or concerns for each specific resource area or study concern. Objectives related to problems are presented on two major levels: desires and preferences.

TABLE 3.1 PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives	
		1st Level (Desires)	2nd Level (Preferences)
Land Use - Agricultural Land	EQ - Loss of open land.	Preserve open land.	Maintain a viable agricultural sector in order to preserve agricultural land and, thereby, preserve an aesthetically pleasing land use mix.
	NED - Loss of agricultural land to nonagricultural uses, thus decreasing agricultural production.	Preserve agricultural land to maintain or increase agricultural output.	Increase net returns to agricultural sector. Determine and minimize the factors that adversely impact upon the agricultural sector.
Land Use - Forestland	EQ - Lack of forest management in urban areas is resulting in a lessening of environmental quality.	Preserve, maintain, and enhance the quality of the environment and the ecological system.	Provide information and education programs on urban forestry. Provide additional technical assistance for management and use of urban forest resources in the region.
	NED - Underutilization of forestland resources for the production of wood products.	Increased outputs of wood products.	Increase management opportunities for forest landowners. Provide forestland management incentives. Increase market opportunities for wood products. Establish and increase information and education programs on forest management.

Inland Flooding	NED - Periodic flooding causes damage to existing residential, commercial, industrial, and public property.	Reduction of flood damage to existing damageable property.	Reduction of flood flows. Reduction of susceptibility to flooding.
	NED - Development of flood prone areas increases the damages to be expected from future floods.	Improved economic efficiency from development of flood-free areas.	Guide development away from flood prone areas.
	NED - Loss of wetland flood storage increases flood peaks and flood damage.	Avoid increased flood peaks and resulting damage.	Protection of wetland flood storage from loss by filling.

TABLE 3.1

PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives	
		1st Level (Desires)	2nd Level (Preferences)
Erosion and Sediment	EQ - Materials eroded from unstable areas are resulting in pollution and sedimentation of water bodies and decreased visual quality.	Enhance water quality. Enhance visual quality.	Install erosion and sediment control measures. Install erosion and sediment control measures.
	NED - Erosion on cropland results in reduced agricultural productivity.	Maintain agricultural productivity.	Reduce erosion losses on those croplands with (about 20%) unacceptable erosion rates.
Wetlands	EQ - Loss or harmful alteration of inland wetlands results in decreased wildlife habitat and visual quality.	Protection of the environmental base.	Protection of wetlands from unwise development.
	NED - Loss of wetland flood storage increases downstream flood peaks and flood damage.	Avoid increased flood peaks and resulting damage.	Protection of wetland flood storage from loss by filling.
	NED - Development of wetlands increases flood damage in the developed wetlands.	Reduce future flood damage.	Protect wetland flood prone areas from development.
	NED - Lack of public access to wetlands is resulting in underutilization of a recreation resource.	Increase wetland recreation opportunities.	Secure public access to wetlands.

TABLE 3.1 PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives	
		1st Level (Desires)	2nd Level (Preferences)
Water Supply	NED - Existing municipal water supplies will be insufficient to meet 1990 needs.	Increase available municipal water supply yield.	Develop new municipal water sources. Improve existing municipal sources and delivery systems.
Water Quality	EQ - Pollution from point and nonpoint sources is degrading water quality.	Improve water quality.	Identify pollution sources and develop abatement measures.
Recreation	EQ - Unique natural, historic, and cultural resources will be lost unless protected. NED - Lack of public access to outdoor recreation resources. NED - Demand for outdoor recreation exceeds available supply.	Management and protection of areas of natural beauty and human enjoyment. Increase recreational opportunities. Increase recreational opportunities.	Protect and manage unique natural, historic, and cultural resources. Secure access to recreation areas. Develop water-based recreational resources.

CHAPTER 4

ECONOMIC PROJECTIONS AND ENVIRONMENTAL CONSIDERATIONS

4.1 HISTORICAL DEVELOPMENT

In terms of major activities, the Central Region has progressed through two economic periods and is presently into a third. The principal activity during initial settlement through the first part of the 1700s was subsistence agriculture. But with the expansion of population in Boston and other centers of trade, demand for food and primary manufactured goods increased. As new technologies were developed, and more land cleared, agriculture production increased while requiring less labor to the extent that some labor was freed to pursue nonagricultural careers. The major industries of this period, were grist mills, sawmills, textile mills, cotton and wool mills, and brick manufacturing. Less important enterprises dealt with the manufacturing of combs, barrels, boots, and shoes, also, some bog iron mining and quarrying. Around 1900 an economic structural change began to occur as the southern states increased their manufacturing in these activities to the detriment of Massachusetts businesses.

Cities such as Lowell and Lawrence, at one time the major textile mill towns in the country, suffered from textile shifts to southern areas which began during the turn of the century. For all intents and purposes, the shift was completed between 1920 and the depression of the 30s. This decline in the textile sector was brought about by two major outside factors. The first factor involved a primary transportation shift from water to land. Initially the railroads brought about this change, which was sealed with subsequent development of more efficient highway systems. The other factor involved the introduction of nonwater generated power systems, initially steam and subsequently, electricity. With the change in these factors, plus higher wage rates, the Region's comparative advantage disappeared and this dictated a manufacturing decline. Although manufacturing has declined, it still dominates the economic activity in the Region.

The agricultural sector has evolved through three economic or production stages:

1. Prerailroad (ending about 1840) -- agricultural production concentrated primarily upon supplying nearby cities.
2. Transition stage (1840-1910) -- staple productions were increasingly coming from western areas (i.e. Indiana, Ohio, New York, etc.).
3. Present pattern (1910-present) -- agriculture primarily involved in providing perishable foods produced near point of consumption.

The three agricultural stages occurred as a result of other changes in the economic structure in the eastern half of the United States. Other regions, endowed with higher quality agricultural production resources, and efficient transportation, developed greater comparative advantages with which the eastern states could not compete. As a result, manufacturing became the predominant economic activity. Exports of manufactured goods were utilized to pay for imports of agricultural goods.

Agricultural, forest, fishing and mining enterprises employ less than half of 1 percent of the total labor force in the region and generate an equivalent amount of personal income. As Table 2.2 showed, although these four sectors are relatively insignificant from a direct employment viewpoint, they do provide inputs to many other sectors. From a resource planning perspective, the fact that over 70 percent of the land area is in agricultural and forestry uses means that the simple economic viewpoint does not suffice. These two sectors become extremely significant in that they are critical components in any resource plan. To the extent that the land use mix is associated with water and related land resource management as well as visual and environmental quality, agriculture and forestland must be prime considerations in resource planning.

The quality of the environment is tied very closely to the extent and type of economic activity being carried on in any particular region. In the Colonial period through most of the 1800s, little concern was given to the waste byproducts (externalities) of production and consumption. Air and water were both

considered free goods with no cost for their use. But as manufacturing grew, and as population increased, the ever increasing amounts of waste became too concentrated to be assimilated into the environment. Once this stage was reached, air and water quality decreased. As this quality decreased, the expense of cleaning these resources increased to the extent that they generated public concern and increased awareness of the need for resources planning. This resulted in state and local legislation, which forced users to recognize the importance of clean environmental resources.

4.2 SOCIO-ECONOMIC DATA

4.2A Population

In 1950, the population in the Central Region was approximately 898,753. By 1960, the population had grown to 1,034,131, an increase of 135,558 (15.1 percent). Between 1960 and 1970, the population grew by 178,606, an increase of 17.3 percent (from 1,034,131 in 1960 to 1,212,737 in 1970). Between 1970 and 1975, the growth of population began to level out and averaged 3.49 percent (an increase of 42,339). Looking at 10 year increments, between 1950 and 1960 the population grew by 15.1 percent; between 1960 and 1970 it grew by 17.3 percent. The 5-year change between 1970 and 1975 would translate into a 10-year growth rate of 6.98 percent. Assuming that this decreasing rate in population growth continues, potential demand influences upon the water and related land resources will decrease. Past and current population and changes between 1950 and 1975 were summarized in Chapter 2, Table 2.1.

4.2B Employment

OBERS data was adjusted to reflect the area in the Central Region. For that reason, the discussion using OBERS data should be considered only as an indication of relative changes in employment and the associated economic activities. Whenever possible, most of the economic material presented here will reflect the characteristics of the Central Region per se. A comparison with OBERS will be undertaken when appropriate.

In 1950, the manufacturing sector clearly dominated the economic picture in the Region, contributing over 57 percent of total earnings. Although this share has decreased since then (51.1 percent in 1960 and 42.5 percent in 1970), it still thoroughly dominates. Wholesale and retail trade in 1950 and 1960 were the next most dominant sector; but by 1970 the service industry moved into second place. Agriculture, forestry, fishing and mining are relatively insignificant and contribute less than 1 percent to total earnings. Table 4.1 summarizes the employment activity in the Central Region between 1950 and 1970.

TABLE 4.1 PERCENT OF TOTAL EMPLOYMENT EARNINGS BY STANDARD INDUSTRIAL CLASSIFICATION CODE 1950-1970

	1950	1960	1970
Agriculture, Forestry, Fishing and Mining	2.1	1.1	.9
Manufacturing	57.2	51.1	42.5
Construction	3.9	4.4	6.1
Transportation, Utilities, Commodities	4.2	4.6	5.9
Wholesale, Retail Trade	14.0	14.1	14.1
Finance, Insurance, Real Estate	2.6	3.9	4.2
Service	7.9	12.0	14.5
Government	8.0	8.8	11.6

Source: 1972 OBERS, Series E, Vol. V, p. 40 and 258.

4.2C Income

The Central Region enjoys a per capita income that has consistently been above the National average. In 1975, the National average was \$5,449 and the State of Massachusetts averaged \$5,757. The Central Region in the same year averaged \$5,843. Expected increases in leisure time together with increases in disposable income will probably result in increased recreational demands and therefore, will result in an increase in demand upon water and related land resources.

4.2D Urban Centers and Their Influences

Major urban areas in the Central Region are: Worcester, Framingham, Leominster, Fitchburg, Lowell, and Lawrence. Although many of the towns are bedroom communities for the Boston metropolitan area, particularly those towns located in the eastern part of the region, Worcester, Lowell, and Lawrence dominate the region. Boston, however, due to its size and proximity, also has a great deal of influence.

4.2E Transportation

The Central Region has a diversified and relatively efficient transportation network. There are numerous interstate, state and local highways in the region. Interstate 495, located east of Worcester runs north and south connecting Lawrence to Lowell and Worcester, and then runs south-southeast until it meets Interstate 95 in Mansfield. The Massachusetts Turnpike (Interstate Route 90) runs in an east-west direction from Springfield to Worcester and then runs east-northeast to Boston. State Route 2 also runs east and west in the northern portion of the region, and connects North Adams in the west to Boston in the east. A large number of state and local roads interconnect the various towns in the region and compliment the major highway system. The major airport serving the Central Region is Logan International Airport, located in Boston at the Winthrop Boston Harbor. Worcester Municipal Airport, Fitchburg-Leominster airport and numerous smaller airports provide flights to other areas of the state as well as to municipal airports in neighboring states.

In terms of railroad service, there are two types: passenger and freight. In the eastern portion of the region, passenger service is excellent since it is tied closely with Boston's transit network. Western portions of the region are not as fortunate. The Worcester-Leominster-Fitchburg area is the third largest in the state relative to economic activity. As such, the area is served by railroads which are utilized to bring in raw manufacturing material and to take out finished manufactured goods. The Central Region is well endowed with a diversified and relatively efficient transportation network.

4.3 AGRICULTURAL RESOURCES AND RELATED ECONOMIC ACTIVITY

4.3A Major Crop and Livestock Enterprises

The Central Region, like the state, has a well balanced agricultural sector. In this region, the value of all agricultural production amounted to \$55,984,000 in 1974. Crops contributed 16.5 percent to this total, livestock 49.4 percent, nurseries and greenhouse operations 33.8 percent and forest products contributed .3 percent of the total.

Agricultural Census Data for the three counties in the Region (Essex, Middlesex, and Worcester) were disaggregated to reflect the portion of each county located in the Region. It was not possible to allocate the census data to reflect the actual boundaries of the substudy areas. As a consequence, the county designations in Table 4.2 approximate a combination of various substudy areas. For example the Worcester designation includes all of the Thames substudy area and the Blackstone, and nearly all of the Nashua. The Middlesex designation incorporates a small proportion of the Nashua substudy area, approximately half of the Merrimack substudy area, and nearly all of the SuAsCo. The Essex designation includes all those towns in the Merrimack study area located in Essex County.

Table 4.2 offers two sets of numbers detailing the cash receipts, and expenditures of all farms and those farms with sales of \$2,500 or more. It is interesting to note that nearly 99 percent of all agricultural production results from those farms having sales of \$2,500 or more, yet these same farms represent only 71 percent of the total number of farms. These farms produce crops and livestock worth a total of \$55,180,000 which averages out to be \$73,770 per farm. On the expense side these same farms had a total cost of production amounting to \$48,279,000 which averages to \$64,544. Net income per farm is slightly more than \$9,000 per farm. In discussing those farms with sales under \$2,500, the picture is not nearly so bright. There were 300 farms in this category in 1974 which had a total value of production equal to \$804,000 and expenditures

to \$892,000 which translates into an average loss per farm of \$293. When it is considered that these 300 submarginal farms encompass an area of 25,721 acres, which is nearly one-fourth of the projected 1990 agricultural base, their exit from agriculture may have serious consequences for the region, if nonagricultural uses replace the agricultural use.

Closely involved with the above figures is the recent enactment of two development rights bills in the Massachusetts General Court. The first bill enables city and town governments to purchase the development rights to farmland, thus precluding development on such land. The second bill provides \$5,000,000 for this purpose. Depending upon the characteristics of the land resource represented by the submarginal farms, it may be that priority in purchasing their respective development rights might have to be applied. Table 4.2 summarizes agricultural data for three categories of farms: all farms, those with sales greater than \$2,500, and those farms with less than \$2,500.

4.3B Employment and Income

As mentioned in section 4.1, in comparison with the total Massachusetts economy, the state's agricultural sector is relatively small, with gross cash receipts of approximately \$202 million in 1974. The agricultural receipts in the Central Region contributed approximately 28 percent to the state total or \$55,984,000. Taking the total cash receipts for all farms and subtracting production expenses of \$49,171,000 results in net income of \$6,813,000. Dividing this figure by the total number of farms in the region results in an average farm net income of \$6,501. When only those farms with sales over \$2,500 are examined, the result is an average net income of \$9,225, nearly 42 percent higher than the all farm average (see Table 4.2).

When discussing employment in the agricultural sector, it should be noted that certain problems exist when such data is compiled. Most employment data in the state is generated through the Massachusetts State Division of Employment Security. A major problem arises because these organizations collect data for employment covered under the statutes which charter them.

TABLE 4.2 VALUE AND COSTS OF AGRICULTURAL PRODUCTION, 1974

	Essex	Middlesex	Worcester	Total Region
	- - - - (thousands of dollars) - - - -			
Value of Ag Production				
All farms	4,168	33,058	18,758	55,984
Farms with sales over \$2500	4,099	32,684	18,397	55,180
Farms w/sales less than \$2500	69	374	361	804
Value of Crop Production				
All farms	816	4,610	3,829	9,255
Farms with sales over \$2500	789	4,504	3,734	9,027
Farms w/sales less than \$2500	27	106	95	228
Value of Forestry Production				
All farms	13	94	60	167
Farms with sales over \$2500	12	86	54	152
Farms w/sales less than \$2500	1	8	6	15
Value of nursery, greenhouse products				
All farms	1,490	16,203	1,230	18,923
Farms with sales over \$2500	1,480	16,190	1,222	18,892
Farms w/sales less than \$2500	10	13	8	31
Value of livestock & livestock products				
All farms	1,848	12,151	13,639	27,638
Farms with sales over \$2500	1,817	11,905	13,386	27,108
Farms w/sales less than \$2500	31	246	253	530
Production Expenses				
All farms	3,811	29,340	16,020	49,171
Farms with sales over \$2500	3,730	28,955	15,594	48,297
Farms w/sales less than \$2500	81	385	428	892
Net Receipts				
All farms	357	3,718	2,738	6,813
Farms with sales over \$2500	369	3,729	2,803	6,913
Farms w/sales less than \$2500	-12	-11	-65	-88
Number of farms	- - - - - Number - - - - -			
All farms	131	443	474	1,048
Farms with sales over \$2500	92	321	335	748
Farms w/sales less than \$2500	39	122	139	300
Average size of farms	- - - - - Acres - - - - -			
All farms	93	85	160	120
Farms with sales over \$2500	110	92	181	134
Farms w/sales less than \$2500	52	68	110	85

Source: 1974 Census of Agriculture

These charters are primarily employment compensation, job referrals, and manpower planning agencies. Although their work has expanded in recent years, their historical data series includes only employment covered by employment compensation acts which amounts to approximately 80 percent of total employment.

4.3C Economic Factors Affecting Agriculture

One of the most obvious signs of poor economic performance of agricultural enterprises is that between 1969 and 1974, agricultural land declined by nearly 20,000 acres from 145,301 to 125,444 acres, a 13.7 percent decline. The most logical explanation for this decline is that individual farmers simply could not afford to stay in production given the alternative sources of income and/or employment.

There are a number of factors which have contributed to the decline of agriculture in the state and in the Central Region. Probably the most significant factor is farm profitability. As was noted earlier, in 1974, 99 percent of the agricultural receipts were accrued by only 71 percent of the farms (the category of farms with over \$2,500 in annual sales) in the Central Region. Thus, there were 300 farms with sales of under \$2,500 a year. When sales income and expenses are combined, those 300 farms had an average 1974 loss of nearly \$295.00. From this vantage point alone, it would seem reasonable that these farms on nearly 25,721 acres may be going out of production, unless supplemented with off-farm generated income.

Many factors impact upon profitability in the agricultural sector: rising labor and capital equipment cost; shortages of labor; alternative employment with greater pay and shorter hours; taxation; lack of a market output infrastructure (e.g., slaughtering houses, processing plants); nuisance laws; higher transportation rates than in competing regions; climate and land. The Governor and the Commissioner of Agriculture in the State of Massachusetts, in viewing the historical decline of the state's agricultural sector, issued a report entitled A Policy for Food in Agriculture in Massachusetts, wherein a policy to preserve agricultural land was set forth. The trend,

from an agricultural perspective, is rather alarming: a decrease from 35,000 farms to a little more than 6,000 since World War II. During the same period, farmland decreased from over two million acres to a little more than 700,000.

As of 1976, Massachusetts was importing 85 percent of all its food. This included 97 percent of its meat, 70 percent of its eggs, 80 percent of its milk, and 90 percent of its potatoes.

It should be noted, however, that at least 25 percent of the state's total food requirements must be supplied from sources outside the state. Of this 25 percent of the total food, 15 percent are comprised of such foods as citrus fruits, tropical fruits, sweet potatoes, rice, etc. The remaining 10 percent of the food comes in the form of fresh fruits and vegetables imported from other regions during those seasons when production is not possible in Massachusetts.

There is no question that a ready market for food exists, but it appears that economic conditions are such that Massachusetts farmers are unable to adequately supply this market. As a result of the high import demand for food commodities, Massachusetts' residents pay from 6-10 percent more for their food than the national average.

As a consequence, the food prices in Boston, for example, are the fourth highest of the 38 major American metropolitan areas. These higher costs have been influenced by high transportation rates (with a decline in rail freight service, a greater reliance has been placed on more expensive trucking) and by the lack of storage facilities in the state.

As initial steps in trying to reverse the trend in agricultural demise, the Massachusetts legislature has recently passed bills whereby the development rights can be purchased on farmland. The rationale behind the program is that the income that a farmer would receive from selling his development rights could then be reinvested in capital improvements, thus making

his operation more efficient and less costly. Land is merely one productive input to a farming operation. However, such a program is, of necessity, a first step.

Tied very closely to the decline in agriculture is the manner in which land resources are allocated to development. Most of the local zoning ordinances zone agricultural land as low density development, at best an inefficient use of a scarce resource. What is necessary is an educational effort whereby local zoning authorities would be able to set more flexible ordinances which would relieve the pressures for development on agricultural land.

It should be pointed out that there are only two food crops in the state wherein production exceeds consumption: sweet corn and cranberries. As a result, it may be necessary to introduce future programs whereby incentives can be generated to produce any given crop or a combination of crops (land, climate, capital, and management permitting). Such a program could involve subsidies, for example, a guaranteed outlet at a guaranteed minimum price.

4.4 FOREST RESOURCE AND RELATED ECONOMIC ACTIVITY

4.4A Extent and Nature of the Resource

Forestland occupies 664,505 acres or approximately 61 percent of the 1,092,056 acres in the Central Region.

A forest is an association of tree species. The tree species associated on a specific land area are a function of soils, sites, climate, and cultural activities. Figure 4.1 shows the general association of trees in the region. Table 4.3 shows tree volume estimates by species and size classes in the region.

al Report will have Detailed
ulti-color forest association map

NEW HAMPSHIRE

MASSACHUSETTS

MIDDLESEX COUNTY

CONNECTICUT

RHODE ISLAND

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1

4.4B Utilization

The forest resource provides goods and services that benefit the region's economy and environment. These goods and services can be grouped to: (1) wood products; (2) water; (3) forage; (4) wildlife and (5) recreation.

Wood Products -- The annual sawlog harvest is about 19,200,000 board feet, valued at \$1,700,000. The majority of the sawlogs harvested are white pine. Other round wood products are composed primarily of fuel wood and some pulpwood. Approximately 2,000 cords are harvested annually, valued at \$40,000.

Water -- Forestland is a source of good quality water. Precipitation falling on forestland is used by the vegetation, evaporated, stored in the soil, or leaves the watershed as streamflow. Streamflow is water yield. Forestland in the region yields 984,000 acre-feet (321 billion gallons) annually, valued at \$2,460,000.

TABLE 4.3 ESTIMATED NET VOLUME OF GROWING STOCK ON FORESTLAND, BY SPECIES, TREE CLASSES

(In Millions of Cubic Feet)			
<u>Species</u>	<u>Total</u>	<u>Species</u>	<u>Total</u>
White Pine	183.1	Paper Birch	12.9
Pitch Pine	13.9	Beech	6.0
Hemlock	21.6	White Ash	9.5
Other Softwoods	17.1	Black Cherry	13.3
Total Softwoods	235.7	Aspen	4.6
		Elm	2.5
Select White Oaks	36.1	Other Hardwoods	4.8
Select Red Oaks	104.5	Total Hardwoods	418.0
Other Oaks	74.4		
Hickory	14.5	All Species	653.7
Sugar Maple	10.4		
Soft Maples	108.6	Sawtimber	304.3
Sweet Birch	10.1	Poletimber	349.4
Yellow Birch	5.8		
		All Classes	653.7

Forage -- There is very little grazing of livestock on forestland. It is unlikely that grazing will ever be an important use of forestland.

Wildlife -- Forestland is a valuable wildlife habitat. Each 100 acres of well managed eastern hardwood forest can support a fall population of: 3 turkey, 3 deer, 25 grouse, 50 rabbit, 100 squirrel, 180 game animals plus 200 fur animals.

Recreation -- Recreational activities can be divided into two broad categories, general and specific. General recreation includes activities attractive to the majority of outdoor recreationists and which generally require the development and maintenance of convenient access and adequate facilities. Activities include picnicking, swimming, sightseeing, camping and hiking.

Special recreation includes activities for which opportunities, in general, are limited, intensity of use is low, and often may involve a large personal expense by the user. Activities include hunting, fishing, backpack camping, canoeing and snowmobile touring.

Forestlands in the Central Region provide approximately 1,500,000 visitor days of general recreation annually valued at \$3,000,000 and about 1,100,000 visitor days of special recreation annually valued at \$5,400,000.

4.4C Cut and Current Growth

The forest resource is underutilized in terms of the potential cut for wood products. A measure of the potential is the growth-cut relationship. Growth is the volume of wood added annually to the inventory of wood and cut is the volume of wood cut annually from the inventory of wood.

Growth averages about 50 cubic feet per acre annually while the cut for wood products averages about 5 cubic feet per acre annually. The growth to product cut ratio of 10:1 indicates that the cut could be increased substantially without touching the inventory base.

The growth-cut ratio does not reveal necessary factors about the resource, such as quality of wood, the economic availability of wood, the volume of wood cut not used for production, and the volume of wood offered for sale by the landowner. These factors together leave only 50 percent of the forestland available for wood products. Chapter 5 discusses land ownership and landowner attitudes in more detail.

4.4D Employment & Income in Primary & Secondary Wood Processing

The primary forest product industry--those companies manufacturing wood products from logs and bolts--is almost exclusively made up of sawmills. No pulp, cooperage, or veneer industries operate in the region. Excluded here are companies or individuals manufacturing fuelwood from logs and bolts. In 1975, 19 commercial sawmills were located in the region. Supplying these sawmills with logs and bolts were an estimated eight logging contractors located in the region.

In 1975, approximately 50 people were employed in the sawmill and planing mill industry. Employee earnings in the sawmill industry is estimated at \$350,000.

The secondary forest product industries--those companies using wood which has undergone some previous manufacturing process and use wood exclusively or partially in a further manufacturing process--is quite an extensive industry in the region. These industries include diversified manufacturing processes. Among these are hardwood dimension and flooring mills, millwork, structural wood members, wood boxes and shooks, wood household furniture, paper mills and paperboard mills. In 1975, approximately 6,100 people were employed in these wood-based industries. Employee earnings in these industries are estimated at \$6,100,000.

Employment in wood-based industries by Standard Industrial Classification Code (SIC) is shown in the following tabulation (Ibid).

<u>Major Group</u>	<u>Employee</u>
24--Lumber & Wood Products (except furniture)	1,100
25-- Furniture & Fixtures	2,100
26--Paper and allied products	<u>2,900</u>
	6,100

4.4E Economic Factors Effecting Forest Resource

Forested land in the region is subject to pressure of urban and industrial developments. The value of forestland solely for the production of wood products cannot compete with the value of converting forestland to these type developments. An estimated 338 acres of forestland are converted annually to other land uses.

Forested land occupies 61 percent of the land area. The extensive forest area speaks well for the potential to make more complete use of the forest resource and the benefits that the forest resource can provide. A number of factors tend to mitigate utilizing the forestland to its potential. The high population density; the high level of development to support the population; the thousands of owners, most of whom own small acreages; the scattered ownership pattern; the diversity of owners' attitudes toward forest property; and the lack of diversified markets for wood products, singly and in combination inhibit an efficient forest management program.

Land to remain in forest cannot effectively compete with land that is to be developed for other more economically advantageous uses. Similarly, the use of forestland for the traditional output of commercial wood products cannot compete effectively with the desires and needs of the people, who for their own solitude, well being, or for whatever nonmonetary reasons own forestland.

4.5 TOURISM AND RELATED ECONOMIC SITUATION

In 1974, tourism in Massachusetts generated over \$1,150,000,000 and contributed approximately 3.5 percent of the total income received in the

Commonwealth from all sources. Employment utilized in the tourism industry amounted to more than 74,400 year round jobs.

A report entitled The Economic Impact of Tourism on the Commonwealth of Massachusetts stated the following "there is probably no industry of any consequence to the Commonwealth--and certainly none as important as the tourism industry--about which so little is known." There are a number of possible reasons for this lack of information:

1. It is an industry with a very large number of enterprises--from giant hotels to part-time one person businesses.
2. Customers are not easily identifiable yet amount to some 33 million per year in the Commonwealth.
3. It is an industry whose product is a service, not a commodity.
4. It is an industry whose services are vastly diverse.

The report noted a rather interesting phenomenon concerning the tourism industry. One of the objectives of the study was to determine whether or not other New England states are competitive with Massachusetts, or if the region as a whole attracts the visitors. If it could be shown that the latter is the case then the relationships of the New England states should be considered supportive, not competitive. The report concluded that visitors tend to come to individual states, rather than to the region as a whole. Visitors generally come to Massachusetts or to one or more of the other New England states. Although the report is a preliminary study, a table of total income generated by tourism in Massachusetts was developed. Table 4.4 summarizes the findings.

As can be seen tourism does play a rather significant role in the economy of Massachusetts. According to Professor Norman G. Cournoyer, University of Massachusetts, 1975 expenditures by nonMassachusetts travelers amounted to \$957,680,000. Of this total, the eastern counties, namely, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Bristol, Barnstable, Nantucket, and Dukes received nearly 92 percent of this total. Looking at Worcester, Middlesex, and Essex Counties, approximately 1 percent of the total is generated here which amounts to over \$10 million. When this figure is adjusted to reflect regional boundaries, the Central Region generates nearly \$5 million.

TABLE 4.4 TOTAL INCOME GENERATED BY TOURISM IN MASSACHUSETTS - 1974

	Accommodations					Total
	Commercial Lodging	Own Cabin, Trailer	Friends & Relatives	Other 1/	Day Trip	
	(thousands of dollars)					
Purpose of Trip						
Business	199,381	264	38,272	4,261	12,565	254,743
Personal Business	108,456	58,321	38,059	2,581	12,305	219,723
Convention	14,622	0	106	5,330	357	20,415
Visit Friends & Relatives	70,288	2,902	192,110	22,501	15,249	303,050
Recreation, Sightseeing, Entertainment	287,992	48,935	17,785	5,186	9,981	369,879
Total	680,739	110,422	286,332	39,861	50,457	1,167,809

Source: The Economic Impact of Tourism on the Commonwealth, OP cited.

1/ "Other" includes nights on a cruise, boat, or other special facilities for accommodation.

4.6 RELATIONSHIP BETWEEN ECONOMIC SITUATIONS AND NED SPECIFIC COMPONENTS

4.6A Land Use

The NED specific components are formulated to minimize the movement of agricultural land into other uses. Due to the higher incomes possible from alternative employments, agricultural land is decreasing because of low returns to the agricultural enterprise. This is a result of inter-regional competition, land prices, tenure and land holding philosophies, physical characteristics of the land (soils, slopes, growing season length, etc.) and marketing and processing infrastructure. It is obvious that a laissez-faire market policy is not conducive to the maintenance of agricultural land. Thus, a public policy which would either artificially (subsidize) or directly impact the agricultural market structure is necessary. To that end, the General Court of Massachusetts passed a Development Rights Act to preserve agricultural land, and then passed a measure providing state funds to acquire these rights. These programs could potentially lower entry costs, tax costs, and develop tenure and land holding philosophies that are more conducive to agricultural operations. The long term application

of these programs, if adequately funded, should enhance the potential for economic growth of the agricultural marketing and processing infrastructure.

In discussing the forestland specific NED components, economic conditions preclude optimism for obtaining objectives. Like the agricultural land resource area, the forestland area suffers from some adverse economic conditions. This is due to inter-regional competition, tenure and land size holding patterns, reasons or philosophies for owning forestland, and minimal availability of primary, secondary, and tertiary wood processing firms. Thus, to attain the NED specific component of increased utilization of the forest resource, requires that an approach be formulated whereby forestland owners can see the "value" of increasing the utilization of the forestland resource.

4.6B Flooding

The specific NED objectives for flooding involves minimizing flood damages in the region by structural measures. Component measures include flood-proofing existing property, guiding development away from flood-prone areas, and protecting wetland flood storage areas from filling or development. With the present economic situation and the present federal and state statutes, the attainment of the NED components is quite realistic.

4.6C Wetlands

The NED components for protecting the wetland resource areas consist of protecting wetland flood storage from filling, protecting flood-prone areas from development, and increasing wetland recreation. Like flooding, given present local, state, and federal statutes and present economic conditions attainment of the NED components is realistic.

4.6D Recreation

According to the state outdoor recreation report, the demand for recreational needs exceeds the available supply and thus, the NED specific component is

to increase public access to outdoor recreation resources and to increase the recreational opportunities so that the difference between supply and demand will be minimized. From an economic perspective, attaining the NED components is not an unwarranted goal. Obviously, if present state financial problems were to continue to exist at the level of the past 3 years, the attainment would be slow. Thus, economically, the status of local and state finances will determine what proportions of the components are attained. A statute limits liability to those landowners who permit public access to their land for recreation use. The question is how much can the state afford to budget towards attaining the recreation objective.

4.7 ENVIRONMENTAL SITUATION

4.7A General Description of Topography

Landforms in the region are the result of glacial activity during the Pleistocene ice age. Topography varies from the slightly rugged hilly uplands of the west to the relatively flat lowland in the east. The hills, streams and many wetlands left by the last glacial period are of great importance to the region.

Tourists are attracted to the region by the beauty of the seacoast, wooded hills and streams. Others enjoy the charm and peacefulness of small villages and quaint countrysides. During the summer months great numbers of people flock to the beaches, streams, and campgrounds to fish and boat, camp or picnic, and enjoy the beauty and outdoors.

4.7B Coastline and Tidewater

The Central Region has a relatively short saltwater shoreline. This coastal area is in the northeast corner of the region where the Merrimack reaches the ocean and is the northernmost saltwater coastline in Massachusetts. This area, though small, has important estuaries and tidal flats. It is one of the major rivers on the Atlantic seaboard.

The Merrimack River due to its natural properties and unique location once supported great numbers of fish including shad and salmon. The Merrimack estuary including its intertidal area and the salt marshes which drain into it has an area of nearly 13 square miles. Pollution and misuse have reduced the river and its estuaries of their former greatness but still they support many types of fish as well as resident and migrant birds.

4.7C Wetlands

The region wetlands have also been a source of enjoyment to residents and visitors. The area has over 82,000 acres of inland wetlands which provide storage for floodwaters, maintain summer flows in the streams, serve as fish and wildlife habitat, and enhance visual quality. In the 1960s residents and governments began to realize that wetlands were being lost at an alarming rate. Developers were buying parcels of cheap swampland, hauling in fill and constructing shopping centers and housing tracts, and then departing to let the new owners be confronted with the problems of high-water tables, settling and cracking foundations, failing septic systems, periodic flooding and a host of related nuisances. In addition, it became apparent that loss of natural flood storage in the wetlands was causing downstream flood peaks to increase, resulting in increased financial losses due to flooding. The loss of wetland wildlife habitat and its effect on certain species was not as dramatic as the other problems but was very real to knowledgeable observers.

In some cases, town governments themselves were unwitting co-conspirators in the loss of wetlands. Zoning regulations encouraged developers to build in many wetlands zoned for industrial or commercial uses. Some towns decided that these "useless swamps" would serve as good municipal dump sites. Similar problems with wetland losses occurred in the saltwater wetland areas. There, fill was being placed in prime wildlife breeding areas to provide more high value real estate.

To counter the loss of wetlands, pioneer legislation was introduced by Representative Francis Hatch. Even to this date, subsequent wetlands legislation is often referred to as "the Hatch Act" even though the original Hatch Act has seen many changes through the years. In addition to restriction laws, Massachusetts has a very active wetlands acquisition program. Two key state agencies involved are the Massachusetts Division of Forest and Parks and the Massachusetts Division of Fisheries and Wildlife. Cities and towns are also involved in wetland acquisition. Cost sharing funds for such community acquisitions are provided from the Massachusetts Self-Help Fund (GL Ch. 132A, Sec. 11) administered by the Massachusetts Division of Conservation Services. The various wetland restriction, control, and conservation measures now available to protect wetlands are described in detail in Chapter 5.

4.7D Inland Water

The Central Region has over 39,900 acres of fresh open water in addition to the 82,000 acres of inland wetlands. There are over 1,380 miles of major streams and tributaries.

Streams in the region vary from low gradient, sluggish ones in the northeast to some relatively steep fast flowing streams in the west. Historically, development, especially industrial, has occurred along the streams. As populations and industry grew, the water quality of the streams deteriorated. Several low gradient sluggish streams with large wetland areas where flushing action is slow developed serious water quality problems. Presently water quality of streams and inland water is generally improving due to the efforts of the towns and industries and public concern of the problem.

Most inland water whether natural or man made reservoirs are relatively shallow. Many are less than 10 feet in depth with most of the deeper ones only 25 to 35 feet. An exception to this is Wachusett Reservoir, the largest body of water in the region which has a maximum depth of approximately 120 feet.

Surface water is used for local water supply in less than half of the towns in the region, and most of these also use ground water sources. Throughout the region and particularly in the southern part, ground water is the principal source of community water. The two major inland waters in the region are Wachusett Reservoir and Chaubunagungamang Lake. There are many additional sites for new surface reservoirs. These may be needed in the future for recreation and water supply. There appears to be a desire on the part of the people to insure that demands for adequate recreation facilities as well as municipal water be met by government.

4.7E Forest

Between 1951 and 1971 MacConnell's work shows an increase in urban land of 108,510 acres and a decrease in forestland of 6,760 acres.

Presently 338 acres of forestland are being lost each year while 5,400 acres of urban land are gained. In the past this urban development has occurred primarily on farmland or open lands; however less farmland will be available in the future for development, thus urbanization of forestland will increase significantly. These land use changes not only affect the forest economy, but they also affect the environmental quality of the area.

The land use changes taking place in the region are decreasing the quality of the environment, and these changes are projected to continue, but at a declining rate in the future. There are ways to have urban expansion and also maintain a good environmental quality. This requires careful land use planning to incorporate the urban and forest environments.

4.7F Population Distribution and Land Use Aspects

The population within the Central Region amounted to 1,255,076 in 1975. With a total land area (excluding water and wetlands) of 1,092,056 acres, or 1,706 square miles, the population density was approximately 736 people per square mile (or 1.1 person per acre). Most of the population, as can be seen in Table 4.5, is concentrated in the Merrimack and the SuAsCo substudy

Population, Land Area, and Population Densities, Central Region, 1950, 1960, 1970, 1975.
Table 4.5

Study Area	1950	1960	Percent Change 1950-1960	1970	Percent Change 1960-1970	1975	Percent Change 1960-1975
Merrimac							
Population	317,947	346,734	9.05	405,116	16.84	424,786	22.51
Land Area (Ac)	210,711	210,711		210,711		210,711	
Densities							
Persons/Acre	1.51	1.65	9.27	1.92	16.36	2.02	22.42
Persons/Sq. Mile	966	1,053	9.01	1,230	16.81	1,290	22.51
Nashua							
Population	127,395	157,140	23.35	178,334	13.49	174,566	11.09
Land Area (Ac)	193,949	293,949		293,949		293,949	
Densities							
Persons/Acre	0.43	0.53	23.26	0.61	15.09	0.59	11.32
Persons/Sq. Mile	277	342	23.47	388	13.45	380	11.11
Blackstone							
Population	266,578	261,549	-1.89	261,780	0.09	257,397	-1.59
Land Area (Ac)	176,215	176,215		176,215		176,215	
Densities							
Persons/Acre	1.51	1.48	-1.99	1.49	0.68	1.46	-1.35
Persons/Sq. Mile	968	950	-1.86	951	0.11	935	-1.58
Assuco							
Population	130,662	204,613	56.60	294,803	44.08	323,816	58.26
Land Area (Ac)	248,067	248,067		248,067		248,067	
Densities							
Persons/Acre	0.53	0.82	54.72	1.19	45.12	1.31	59.71
Persons/Sq. Mile	337	528	56.68	761	44.13	835	58.14
Thames							
Population	55,991	64,095	14.47	72,704	13.43	74,511	16.25
Land Area (Ac)	163,114	163,114		163,114		163,114	
Densities							
Persons/Acre	0.34	0.39	14.71	0.45	15.38	0.46	17.95
Persons/Sq. Mile	220	251	14.09	285	13.55	292	16.33
Central Region							
Population	898,573	1,034,131	15.09	1,212,737	17.27	1,255,076	21.37
Land Area (Ac)	1,092,056	1,092,056		1,092,056		1,092,056	
Densities							
Persons/Acre	0.82	0.95	15.85	1.11	16.84	1.15	21.05
Persons/Sq. Mile	527	606	14.99	711	17.33	736	21.45

Source: Population figures from Table 2.4. Land acreage from MacConnel, et al.

areas. In the former, population density per square mile is equal to 1,290 persons, and in the latter, it is 835 persons per square mile. In terms of historical growth, the SuAsCo substudy area leads the list: 56.6 percent between 1950 and 1960, 44.08 percent between 1960 and 1970, and 58.26 percent between 1960 and 1975. Only one substudy area, the Blackstone, lost population between 1960 and 1975 and that amounted to 4,383 persons or 1.59 percent loss.

It is important to note that from an environmental perspective, there appears to be enough water and related land resources to satisfy future resource demands without resulting in the degradation of environmental quality. Such results can only be achieved, however, if future growth is guided away from environmentally sensitive areas to those locations which can adequately accommodate future developments. Also required is an enactment of means whereby desirable growth forms are permitted. For example, most agricultural and forested land is zoned for low density residential. Such ordinances result in extensive developments which consume not only large acreage but also provide the vehicle for urban sprawl and increased service requirements. Therefore, if a regional goal is to preserve agricultural land, and if zoning ordinances are not modified to permit more intensive uses of land (e.g., cluster developments, planned unit developments, etc.), it is doubtful whether preservation goals can be obtained.

4.8 PROJECTIONS

4.8A Methodology (Projection Procedures and Relationship to OBERS)

General -- A major objective of the Massachusetts Water Resource Study is to project a number of important variables (land use, population, income, etc.) and thereby identify areas that may experience potential problems. Once potential problems are recognized, alternative policies can be developed which have as their objective, the minimization of such problems.

The growth of any region and the quality and quantity of its water and related resources are closely interrelated. This is obvious when it is

considered that new development creates demand for water (drinking, recreation, waste disposal) and land which may result in an encroachment upon ecologically and economically sensitive areas (e.g., flood plains, wetlands, and lands overlying aquifers). Projections are utilized to determine the extent and rate of development (or the decline therein) and whether or not increased demands upon the resource base can be met with a set of projected resource suppliers (water, land, transportation, etc.). Problems arise to the extent that critical resources of minimum quality and quantity can satisfy or not satisfy such demands. For example, federal and state land use policies have placed a high priority on the preservation of agricultural land (specifically, prime agricultural land). In the past, much of the development in the region has been at the expense of agricultural and forestland. Given the priorities on preserving such land, future growth and land demand give an indication of what is likely to occur, given recent trends. Such forward looking procedures also indicate the extent to which future growth must be guided.

Some of the economic activity-type projections were taken from OBERS projections, Series E, and were then disaggregated to more closely approximate the boundaries of the Central Region. In using the OBERS projections, the intentions thereof are clearly described by the Director of Water Resources Council:

The OBERS projections are intended as a planning tool, as a contribution to planning decisions. Wherever water and related land development problems may be solved by alternative levels of growth, through more or less resource development, full consideration should be given to such action, uninhibited by the projections contained in this report.

The OBERS projections are not a goal. It is not intended that they be used as assigned shares, or quotas. They are not intended as a constraint on any region's economic activity. They do not express what is desirable or undesirable.

There are a number of assumptions utilized in the preparation of the OBERS Regional projections. These are specified in detail in Vol. I of the 1972 Series E OBERS. In some instances, these assumptions may or may not be to any one particular region. State and local planners should compare those assumptions used in the formulation of the OBERS projections to determine which ones are applicable and the amount of adjustment needed to bring them into compliance with what exists in the region.

Population -- There were two population projections available for use in this study. The first was the OBERS projections developed by the Bureau of Economic Analysis and the Economic Research Service, and the second source was the Regional Planning Commissions located in the Central Region. Although the two projection sources suggested similar rates of growth, projections supplied by the Regional Planning Commissions were used in this study. The primary reason for this decision was three-fold:

1. The geographic configuration of the region presents many difficulties in accurately allocating various OBERS SMSA population data to the Central Region.
2. OBERS projections were developed using 1972 data whereas the various planning commissions used up-to-date information and more recent trends for their projection base.
3. National projections are disaggregated first to states, then to regions and finally to subregions.

For each disaggregation, the probability of error increases correspondingly.

Economic Projections -- Economic projections were taken from OBERS data as well as Office of State Planning Data. Historical and projected economic data were gathered for the Boston and Worcester-Leominster-Fitchburg SMSA's and were adjusted to reflect the boundaries in the Central Region. The adjustment factors were computed using economic data supplied by the Massachusetts Department of Commerce and Development in city and town monograph publications. In view of the fact that two different sources of data were used, complete uniformity was impossible. However, the direction and

velocity of identifiable trends are more relevant considerations than simply the absolute numbers. In this light, the fact that there may not be consistent and uniform comparisons should not detract from the validity of the analysis.

Land Use Projections -- A number of methodologies were utilized to project the various land use categories. Agricultural land was projected by using historical agricultural land data which were compiled from the 1949, 1954, 1959, 1964, 1969, and the 1974 Census of Agriculture. The historical land use data was weighted heavier in the latter years of the data set (1964 through 1974) to more accurately reflect recent trends. In some cases, it was necessary to allocate data from those counties which were located in more than one study region to the particular area included in the Central Region. For example, Essex County is in two regions--the Central and the Coastal. Middlesex is also in both regions. In addition, portions of Worcester County are in the Central as well as in the Connecticut Region. The allocation was accomplished by using MacConnell's Land Use Data to first determine the amount of agricultural land by category in each town in each respective region. Once these proportions were computed, they were then used to adjust the County Census data to reflect that data located in each of the various regions. After the adjusted census data were enumerated for each substudy area, a Markov probability program was used to project the 1990 shares that each agricultural land use category would contribute to the total land in farms. The total land in farms on the other hand was computed using two different methodologies: OBERS, Series E Report projections; and developing another Markov probability program. Each of these projected totals were then multiplied times the projected 1990 shares each agricultural land use category contributes to that total. It should be noted that the OBERS total land in farms projection is significantly higher than the Markov projection. This difference can be attributed to the methodology utilized in the OBERS projection, and the fact that the Markov program is based solely upon historical relationships.

The State OBERS projections are based upon a National projection which was first disaggregated to a regional basis, and then disaggregated further to

generate the state projections. On a National basis, recent trends in agricultural land have shown a leveling off in agricultural land declines. Consequently, this leveling off was reflected in both the Regional and the State disaggregations. As a result, especially with respect to Massachusetts, the leveling off aspect resulted in a much more optimistic projection than that suggested by the Markov probability projection. The Markov method may be considered the more pessimistic projection simply because it heavily weights the recent trends of agricultural decline.

Urban land was projected by using a log-linear regression model that was run on MacConnell's data. For the purposes of this study, urban land was defined as industrial-commercial, residential, and institutional (schools, hospitals, etc.). Share of urban land by town and population density variables was aggregated to the substudy area level. A number of regression equations were formulated and regressed. The "best" equation was utilized to project urban land acreage to 1990. In addition to MacConnell's Urban Land Use data, population projections supplied by the various planning commissions in the region were also used. The population density model tied together with historical urban land acreage was found to "fit the best." Base year data for 1951 and 1971 were used to estimate the regression coefficients for the entire Central Region. Similar regressions were also calibrated by substudy area to reveal regional differences. Weighted aggregations of these coefficients by region and by substudy area for 1951 and 1971 were used in the final regression model to project urban land use by subregion for 1990. This model is very efficient relative to larger land use models for it makes use of minimal data requirements. In addition, changing assumptions such as future population growth rates or per capita demand for land would require only simple adjustments to the model parameters and/or the data base.

Projected area for open water in 1990 is considered to be approximately the same as the 1971 figure of 38,956 acres since no large future water impoundment projects are under consideration between now and 1990.

Wetland projections to 1990 were based on historical trend analysis and adjusted to reflect the Wetland Restriction Acts presently in force in Massachusetts. Based on these factors, it was estimated that wetlands would decrease at the rate of .4 percent per year through 1990.

Forestland was projected by adjusting MacConnell's Land Use data to exclude forestland on farms and wooded wetlands identified by the Soil Conservation Service in 1976. Forestland on farms and wooded wetlands were subtracted from the 1971 forestland acreage because these two categories of land use are projected in the agricultural land projections and the wetland projections respectively. The final projection dealt with the "other" land category, and was projected as being the residual from all other acreage in the above land use categories.

4.8B Population and Economic Projections

Population -- Population projections gathered from the various Regional Planning Commissions in the Central Region show population increasing in all regions through 1990. At that time the regional population is expected to be approximately 1,485,257 people, an increase of 230,181 or nearly 18.4 percent greater than the 1975 population of 1,255,076. Thus, there will be an average 6.13 percent increase in population every 5 years.

Although direct comparisons with OBERS projections are not possible in terms of absolute numbers, similar rates of growth are projected. Whereas the various regional planning commissions have projected a change of 22.5 percent between 1970 and 1990, OBERS projections amount to 22.3 percent for the same period. Although the rates of growth are similar for each of the two projection sources, the figures utilized in this report are those from the Regional Planning Commissions because of the following characteristics of the OBERS population projections:

1. The geographic configuration of the region presents difficulties in accurately allocating the various OBERS SMSA population data through the region.

2. OBERS projections were developed using 1972 data whereas the various planning commissions are using more up-to-date information and more recent trends.
3. The OBERS projections are disaggregated National projections, first to states, then to regions, and finally to subregions. For each disaggregation the probability of error increases correspondingly.

Table 4.6 summarizes the population projections for the Central Region.

TABLE 4.6 POPULATION PROJECTIONS, 1975-1990, WITH PERCENTAGE CHANGES

Substudy Area	1975	1980	1985	1990
Merrimac	424,786	455,726	483,858	509,369
Nashua	174,566	191,597	202,502	212,924
Blackstone	257,397	262,622	266,142	269,652
SuAsCo	323,816	354,547	380,048	402,573
Thames	74,511	82,522	86,665	90,739
Total	1,255,076	1,347,014	1,419,215	1,485,257
- - - - - Regional Changes - - - - -				
Years	1975-1980	1975-1985	1975-1990	
Change	91,938	164,139	230,181	
% Change	7.32	13.08	18.34	

Economic Projections -- The relative changes between 1950 and 1970 are expected to continue between 1975 and 1990. For example, manufacturing earnings in 1975 were \$1,133,252,628. In 1990, these earnings are expected to increase to \$1,616,365,542. The service related industries (finance, insurance, real estate, services and government) are expected to increase from \$1,541,978,934 in 1975 to \$3,403,479,424 in 1990.

As can be seen in Table 4.7, the service-related enterprises are expected to increase 137 percent above their 1975 level by 1990. Looking at the total economic picture, total earnings are expected to increase by slightly more than \$3.1 billion or an 81 percent gain.

TABLE 4.7 POPULATION, EMPLOYMENT/POPULATION RATIO & EARNINGS BY INDUSTRY, 1975, 1980 and 1990

		Merrimack	SuAsCo	Blackstone	Nashua	Thames	Total
Population, midyear		424,786	323,816	257,397	174,566	74,511	1,255,076
Employment population ratio		.37	.39	.49	.35	.31	.39
		(X 1,000 1967 \$) - - - - -					
Agriculture, forest mining & fisheries	1975	6,196	4,829	5,916	2,879	1,104	20,922
	1980	7,057	6,045	6,451	3,096	1,282	23,930
	1990	8,056	7,493	6,300	3,375	1,448	26,672
Contract construction	1975	87,618	70,065	50,410	24,531	9,405	242,030
	1980	105,739	90,577	58,527	28,083	11,631	294,558
	1990	146,898	136,634	73,008	39,114	16,782	412,436
Manufacturing	1975	323,729	258,875	329,101	160,151	61,398	1,133,253
	1980	366,475	313,927	358,209	171,881	71,186	1,281,678
	1990	467,521	434,856	404,383	216,649	92,955	1,616,366
Transportation, com- munications & utilities	1975	91,458	73,136	51,721	25,169	9,649	251,133
	1980	111,524	95,533	63,026	30,242	12,525	312,850
	1990	161,858	150,549	80,274	43,007	18,452	454,140
Wholesale & retail trade	1975	234,477	187,504	125,602	61,122	23,433	632,138
	1980	276,066	236,481	156,738	75,208	31,148	775,641
	1990	370,831	344,922	195,370	104,670	44,910	1,060,703
Finance, insurance and real estate	1975	99,687	79,717	39,887	19,410	7,441	246,143
	1980	123,502	105,793	51,567	24,744	10,248	315,853
	1990	181,167	168,509	68,872	36,899	15,832	471,278
Services	1975	300,808	240,546	148,158	72,098	27,641	789,250
	1980	424,637	363,749	199,137	95,553	39,574	1,122,651
	1990	697,638	648,895	297,326	159,293	68,346	1,871,498
Government	1975	185,509	148,345	103,235	50,237	19,260	506,586
	1980	244,320	209,287	125,755	60,342	24,991	664,695
	1990	369,602	343,779	170,789	91,501	39,259	1,014,930
Total	1975	1,329,482	1,063,016	854,030	415,598	159,330	3,821,455
	1980	1,659,319	1,421,391	1,019,410	489,149	202,586	4,791,856
	1990	2,403,571	2,235,637	1,296,323	694,507	297,985	6,928,023

Source: OSP employment projections and earnings, from OBERS Projections

Employment projections indicate that manufacturing earnings will have the greatest decrease in percent of total employment earnings, while service will increase the most. The present and projected distribution of employment earnings, by percent, are shown in Table 4.8.

TABLE 4.8 EMPLOYMENT EARNINGS (PERCENT DISTRIBUTION, SIC) 1975-1990

	1975	1980	1990
Agriculture, Forestry, Fishing and Mining	0.5	0.5	0.4
Construction	6.3	6.1	6.0
Manufacturing	29.7	26.7	23.3
Transportation, Utilities, Commodities	6.6	6.5	6.6
Wholesale, Retail Trade	16.5	16.2	15.3
Finance, Insurance, Real Estate	6.4	6.6	6.8
Service	20.7	23.4	27.0
Government	13.3	13.9	14.6

Source: Massachusetts Office of State Planning and OBERS Projections.

In reference to the objectives of the study, the question must be asked, how will or how might the expected economic and social trends affect the region's water and related land resources? And this question can be answered by determining what new demands will be placed on these resources. Given the present amounts of nondeveloped land, excluding environmentally sensitive lands, with proper land use guidance, the overall growth, both economic and social, can be satisfied with the region's water and related land resources.

OBERS projected potential need for wood product production is 6.4 million cubic feet by 1980 and 7 million cubic feet by 1990. OBERS estimates are based on the total commercial forestland acreages and land productivity.

4.8C Land Use Projections

Agricultural Land -- As discussed in 4.7A a number of methodologies were utilized to project various land use categories to 1990. These categories are as follows:

- | | |
|------------------------------|-------------------------------|
| 1. Agricultural land | 2. Urban land |
| a. Total cropland | a. Industrial-commercial land |
| (1) harvested cropland | b. Institutional land |
| (2) pasture/grazing cropland | c. Residential land |
| (3) all other cropland | 3. Open water areas |
| b. Forestland | 4. Wetlands |
| c. All other farmland | 5. Forestland |
| d. Total land in farms | 6. All other land |

As Table 4.9 reflects, there are significant differences in the two projection techniques. For reasons discussed in Section 4.5A, the OBERS projection should be considered the optimistic projection and the Markov projection should be considered the pessimistic projection. In other words, the data reflected on Table 4.9 should be considered the range of probable agricultural land acreage in 1990.

What projection technique should be utilized? Given the methodology used in the OBERS report and the multitude of assumptions contained therein, the Markov technique more accurately reflects the trends that have recently occurred in the Central Region. Such a projection suggests a precipitous decline in agricultural land amounting to 68,917 acres (or a 50.36 percent decline) between 1974 and 1990. Using the OBERS projection, the trend suggests a decline of 22,623 acres (or 16.5 percent). Given the dynamics of land use change, especially for a category which is declining at such a rapid rate the intensity of use on such land usually increases. As the intensity increases, the value of production increases which, theoretically at least, would suggest a decreasing rate of decline. Thus, the Markov agricultural land projection should be considered as the more pessimistic projection.

TABLE 4.9 AGRICULTURAL LAND USE, BY ACRES, 1974-1990, USING OBERS AND MARKOV PROBABILITY PROJECTION TECHNIQUES

	1974 (acres)	1990 OBERS MARKOV (acres)		Differences between two projections
Total Cropland	61,626	54,688	32,524	22,164
Harvested cropland	45,695	41,919	24,930	16,989
Pasture/grazing cropland	12,632	9,697	5,767	3,930
All other cropland	3,297	3,072	1,827	1,245
Woodland on Farms	51,921	37,955	22,573	15,382
All Other Farmland	23,307	21,587	12,839	8,748
Total Land in Farms	136,853	114,230	67,936	46,294

Given the recent trends in agricultural land use decline, it appears that the actual 1990 agricultural land acreage will, however, be closer to the Markov than to the OBERS figure.

The recent passage of bills to allow for public purchase of development rights may have a positive impact upon the retention of agricultural land. As the development rights to a particular farm are purchased by the public, value of the farmland would then decrease from the market-development potential to a value derived from its agricultural production potential. As a result, the largest barrier to entry, namely the high cost of land would decrease substantially. In addition, taxes which were formerly derived from market-value assessments would then be assessed on the agricultural value, and as a result, the cost of ownership would decrease. Further, "A supply of land from which development rights had been removed would create a "market" for farmland at farm supportable prices in which a farmer who needed it could buy land to bring his operation to a more (economically viable) size."

Urban Land -- The projected urban land area for the entire Central Region is expected to amount to 276,051 acres by 1990. With respect to the substudy areas, the following projections are noted: Merrimack, 77,896; Nashua,

43,875; Blackstone, 44,079; SuAsCo, 84,191; and Thames, 25,380. The percent changes between 1970 and 1990 are 40.7, 38.6, 32.9, 60.8, and 84.5, respectively.

Translating these percentages to the Central Region area, it is expected that a 48.2 percent increase (or an increase of 89,773 acres) in urban land will occur by 1990. Thus, wherein 1970 urban land was approximately 17.1 percent of the total Central area, by 1990 it is expected to amount to 25.3 percent.

Water -- The 1990 projection for open water area is expected to remain approximately the same as the 1971 figure of 38,956 acres.

Wetland -- Wetland projections to 1990 suggest that there will be approximately 77,429 acres in this category. This amounts to a decline of 4,590 acres for a total decline of slightly more than 5 percent (or .4 percent annually) between 1970 and 1990.

Forestland -- 550,803 acres of forestland (excluding wooded wetland and woodland on farms) is expected by 1990. Adjusting MacConnell's 1971 figure to exclude woodland on farms and wooded swampland, results in a figure of 556,259 acres. Thus, there is an expected decline of 5,456 acres (0.98 percent).

Other Land -- The final projection dealt with the "other" land category. This category was projected as being the residual from all other acreage in the above land use categories. The 1990 OBERS projection amounts to 34,587 acres or a decline of 57,104 acres representing a 62.28 percent loss. The 1990 Markov projection, however, calls for a figure of 80,881 acres representing a loss of 10,810 or a decline of 11.8 percent. The increase over the OBERS other land projection reflects the additional acreage available resulting from the Markov agricultural land projection. Table 4.10 summarizes the OBERS and Markov 1990 land use projections.

TABLE 4.10 LAND USE CHANGE, BY ACRES, 1971-1990, USING MARKOV AND OBERS PROJECTION TECHNIQUES

	1971	1990		Change OBERS	1971-1990 MARKOV	Percent OBERS	Change MARKOV
		OBERS	MARKOV				
Agricultural Land	136,853 1/	114,230	67,936	-22,622	-68,917	-16.53	-50.36
Water	38,956	38,956	38,955	--	--	--	--
Wetland	82,019 2/	77,429	77,429	-4,590	-4,590	-5.6	-5.6
Forest	556,259	550,803	550,803	-5,456	-5,456	-0.98	-0.98
Urban	186,278	276,051	276,051	89,773	89,773	48.19	48.19
Other	91,691	34,587	80,881	-57,104	-10,810	-62.28	-11.8
Total	1,092,056	1,092,056	1,092,056	--	--	--	--

1/ Agricultural Land acreage is for 1974.

2/ Wetland acreage is for 1976.



CHAPTER 5
RESOURCE BASE AND EXISTING PROGRAMS

5.1 RESOURCE BASE

5.1A General

The Central Region, approximately 1,706 square miles, lies between the Coastal Region and Connecticut River Region. It includes parts of three river basins, the Merrimack, Thames, and Blackstone. The Merrimack River lying within Massachusetts flows generally northeast directly into the Atlantic Ocean, and drains most of the northern two-thirds of the region. The upper reaches of the Thames and Blackstone Rivers drain the remaining southern one-third of the region. These two rivers flow in a southerly direction with the Thames River flowing through Connecticut into Long Island Sound and the Blackstone River through Rhode Island into Narragansett Bay. Little attention is focused here on the coastal shoreline as it effects only a few towns in the northeast where the Merrimack River flows into the Atlantic Ocean.

For the purpose of this study the Merrimack River has been divided into three (3) subdrainages. These three along with the other two rivers make up the five Study Areas used in this report. Major streams within each Study Area are shown below.

<u>Study Area</u>	<u>Major Streams</u>
Merrimack	Merrimack River Shawsheen River
SuAsCo	Assabet River Concord River Sudbury River
Nashua	Squanacook River Nashua River Stillwater River Quinapoxet River Nissitissit River

Study Area - cont.

Blackstone

Thames

Major Streams

Blackstone River
Kettle Brook
Quinsigamond River
Mill River
Mumford River

Quinebaug River
French River

The Central Region consists of 79 cities and towns. It is comprised of portions of Worcester, Middlesex, Essex and Hampden Counties.

The region is generally inland from the heavily populated coastal areas. Towns population densities, based on 1970 U.S. Census, range from a high of 9,092 persons per square mile in the highly urbanized city of Lawrence to a low of only 41 persons per square mile in Holland. There are four cities or towns with population densities over 2,000 persons per square mile and eight towns with 100 or less persons per square mile.

Region boundaries were originally selected based on the hydrologic watershed boundaries as being natural dividing lines for a study of water and related land resources. Because of the importance of municipal governments in planning and implementing measures in Massachusetts, it was decided to adjust the hydrologic region boundaries so that all of a town's area could be assigned to one region. Those towns included in the Central Region are shown on Figure 1.1.

5.1B Soils of the Central Region

The soils of the Central Region have formed in materials influenced by glaciation. The region's many upland hills, drumlins and ridges are covered with 2 or 3 feet of friable loamy material underlain by firm, loamy or sandy heterogeneous glacial till. Stones and boulders are normal surface features in wooded areas. Bedrock outcrops are especially common on steeper slopes.

Intermingled with the uplands, in valleys and lower positions, are soils formed in materials influenced by glacial meltwater. These areas range from nearly level to moderately steep with shorter slope lengths than the nearby upland hills. Soils in these areas are quite varied, but all have substrata of sand or sand and gravel. The surface soil and subsoil portions may be silty, loamy or sandy and contain varying amounts of gravel.

Minor areas in the northeast part of the region include beaches, sand dunes and soils formed in old clayey lake and marine deposits.

The General Soil Map for the Central Region is on Figure 5.1. Five broad groups, or associations, of soils are indicated. They are discussed below.

1. Paxton-Hollis-Canton association -- The soils in this association formed in glacial till deposits. They occupy gently sloping to steep land forms of drumlins and ridges throughout the uplands of the region. These soils have fine sandy loam surfaces. The surfaces of wooded areas often have many scattered stones and boulders. Bedrock outcrops are common in some areas, primarily on the steeper slopes. These soils are well drained to excessively drained and are free of problems associated with soil wetness.

This association is dominated by three major soils. The Paxton soils have loamy, slowly permeable substrata. They make up about 50 percent of the association. The shallow to bedrock Hollis soils constitute about 15 percent. The Canton soils have permeable sandy substrata and make up about 10 percent of the association. The remaining 25 percent of the association consist of numerous minor soils.

2. Hinckley-Windsor-Muck association -- The soils in this association formed in water sorted materials, primarily glacial outwash, and in pockets of organic materials. They are generally in the valleys on nearly level to rolling terraces, deltas, kames and eskers. Numerous areas of this association are suited for agriculture. Many soils in this group are free of water table problems

Soil Associations

1. Paxton-Hollis-Canton association
2. Hinckley-Windsor-Muck association
3. Dune land-Tidal marsh-Beaches association
4. Scantic-Hollis-Maybid association
5. Canton-Paxton-Merrimac association

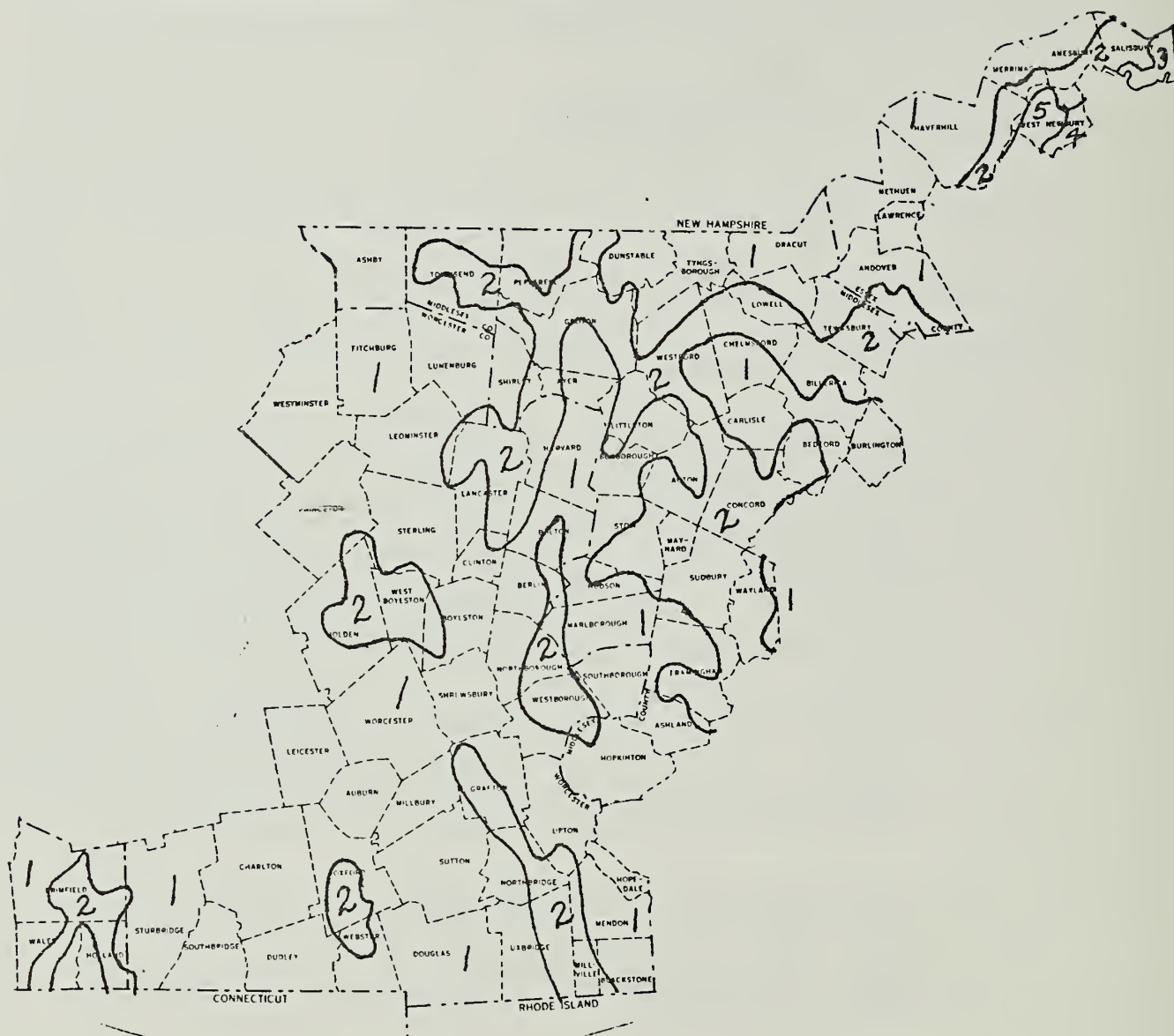


Figure 5.1

General Soil Map



and in fact are limited by drouthiness. Muck soils unless drained are too wet for most crops.

This association is dominated by three major soils. The permeable Hinkley soils have sandy or sandy and gravelly substrata. They constitute about 40 percent of the association. The Windsor soils have sandy subsoils and are also very permeable. They make up about 30 percent of the unit. The wet organic Muck soils make up about 10 percent of the area. A number of other soils minor in extent make up the remaining 20 percent.

3. Dune land-Tidal marsh-Beaches association -- This group is very minor in the region, occuring only in a small area near the ocean. The association consists of oceanwashed beaches, the adjacent deep, sandy, rolling dunes and tide indurated salt grass flats. The salt grass tidal marsh is behind the dunes and extend inward along the streams. These areas are used primarily for wildlife and recreation. The dunes are only partially vegetated due to the wind action off the ocean.

Three types of land are dominant in this association. Dune land makes up about 40 percent of the area. The wet tidal marsh, formed in thick accumulations of partially decomposed plant remains, comprise 35 percent of the association. The barren beaches constitute about 10 percent of the area. Other minor soils comprise the remaining 15 percent of the association.

4. Scantic-Hollis-Maybid association -- The soils in this association formed in clayey lake, or marine deposits. This association is a minor part of the Central Region. The soils are predominantly on nearly level flats in the extreme northeast part of the region. These are primarily poorly or very poorly drained, slowly permeable, clayey soils. Bedrock outcrops are common in some areas. Wetness and restricted permeability are problems for most uses of these soils.

The Scantic, Hollis and Maybid soils are dominant in this association. Hollis soils are shallow to bedrock, but Scantic and Maybid soils are deep to rock. Scantic soils make up about 40 percent, Hollis soils about 20 percent and Maybid soils another 20 percent of the area. Other minor soils comprise the remaining 20 percent of the association.

5. Canton-Paxton-Merrimac association -- This association consists of soils formed in glacial till as well as soils formed in water sorted glacial outwash. These contrasting materials are closely intermingled in a small area in the northeast part of the region. These soils are on nearly level to undulating terraces and gently sloping to moderately steep upland ridges. They have fine sandy loam surfaces. Wooded areas of the Canton and Paxton soils often have surface stones, and bedrock outcrops are in some areas. The lower slopes of all these soils are suited to agriculture. They are all well drained so soil wetness is not a problem. The Canton and Merrimac soils have permeable sandy substrata. Paxton soils have compact slowly permeable substrata.

Three soils dominate this association. It is comprised of about 50 percent Canton soils, 20 percent Paxton soils and 20 percent Merrimac soils. Other minor soils make up the remaining 10 percent.

5.1C Geology

The Central Region includes portions of three sections of the New England Physiographic Province. They are, in a west to east direction, the New England upland section, the seaboard lowland section, and a small bit of the New England shore section. Accordingly the topography varies from slightly rugged and hilly in the west to relatively flat and low lying in the east. A close scrutiny of topographic details reveals a variety of landforms related to glaciation during the Pleistocene Epoch.

Various types of igneous, metamorphic and sedimentary bedrock occur in the Central Region. The geographic location and extent of any given rock type is often difficult to predict. The bedrock is generally hard and water tightness usually increases with depth. Water-bearing broken zones may occur in the uppermost several feet of the bedrock. Yields in bedrock wells usually are relatively low, and are adequate for only one or two families from a given well. An important body of granitic rocks exists in a line roughly running between Worcester and Lowell. These granites are still quarried for use as dimension stone.

Most of the unconsolidated deposits in the region owe their origin to the Pleistocene glaciation. Glacial till, consisting of a mixture of silt, sand, gravel, and boulders, occurs on the crests and flanks of the higher hills where bedrock is not exposed at the ground surface. Elsewhere, the till is often present in the subsurface beneath other unconsolidated deposits. The till is not a good source of sand and gravel due to its muddy and stony nature. However, it is an excellent source when relatively watertight soil is required for example, in a dam embankment. Water wells in till generally have a low yield.

When the glaciers melted, sand and gravel were deposited by the resulting streams. The deposits have a wide variety of topographic shapes, including outwash plains, terraces, sinuous ridges, and clusters of small hills. These deposits are best developed where the glacial deposits have filled preexisting valleys in the bedrock. Such areas have a high potential for ground water supply. The sand and gravel are quarried throughout the Central Region, including some relatively large washed sand and gravel operations.

The relatively wide, flat areas in the major river valleys are underlain by deposits of silt, sand, and clay. These areas are the sites of ancient lakes, formed when blocks of ice and other debris from the melting glaciers temporarily formed dams on the rivers.

Several earthquakes have been reported in the Central Region. In general, the seismic risk increases from moderate in the west to high in the east. The northeastern corner of the region is a part of one of the most seismically

active zones in eastern North America. Some damaging earthquakes have been associated with this zone. Therefore, serious consideration should be given to earthquakes during design of engineering works, especially when foundations are in unconsolidated deposits.

5.1D Vegetative Cover

Approximately 83 percent of the region is in nonurban uses. Forestland is by far the most dominant with 664,505 acres comprising 61 percent of the total land area. Hardwood forest is the dominant forest vegetation type; approximately two-thirds of the forest volume is in hardwoods. The major hardwood species are red oaks and soft maples. The major softwood species is white pine. The remainder of the nonurban land can be divided into cultured lands with agricultural crops including grasses and legumes and noncultured land. Wetlands and transitional lands such as abandoned fields and orchards are the major examples of the noncultured lands. If left alone, the transition lands will ultimately revert to forest through natural plant succession.

5.1E Climate

The average annual temperature is about 49° Fahrenheit (°F). Averages vary depending on the elevation, slope and other environmental aspects. Temperatures have been recorded below minus 30°F to highs of over 105°F. The growing season (frost-free period above 32°F threshold) averages from 140 to 160 days. Mean annual precipitation is about 44 inches and is rather evenly distributed throughout the year. Snowfall averages from 50 to 60 inches. Topography has a marked influence on snowfall causing much variation in short distances. The average annual runoff is about 22 inches or about one-half of the annual precipitation. See Figures 5.2, 5.3, 5.4, Climatological Data.

5.1F Storms and Droughts

Major storms have occurred in nearly every month of the year. "Northeasters"

are one of the most serious storms. They generate very strong winds and heavy rain or snow. In winter these storms produce the heaviest snow, and during fall and spring are one of the more frequent causes of flooding. Some of the severest floods have been those associated with hurricanes or storms of tropical origin in late summer or early fall. The more significant flood producing storms of this century were the hurricanes of September 1938, August 1955 and September 1960, and the nonhurricane storms of November 1927, March 1936, November 1953, March 1963 and March 1968.

Droughts have occurred in the region with the longest in recent memory extending from 1962 to 1967.

Stream gage data from U.S. Geological Survey Stations throughout the region is abstracted in Table 5.1.

5.2 LAND USE

5.2A Agricultural Land

Land use in the Central Region is dominated by forestland which comprises 61 percent of the region. Urban land, the next most dominant land use, comprises slightly more than 17 percent of the total acreage in the region. Agricultural uses comprise 9.4 percent of the area while water, wetlands, and other land uses make up the balance.

In the 20-year period between 1951 and 1971, significant land use changes occurred. Regionally agricultural land decreased by slightly more than 100,000 acres or more than 50 percent of its agricultural base. In 1951, 18.9 percent of the region was in agricultural use, by 1971, only 9.4 percent was in such uses. The SuAsCo Study Area lost the most, 33,853 acres or 59.7 percent of the 1951 agricultural land base. The Merrimack Study Area lost 25,795 acres or 54.4 percent, resulting in a 1971 agricultural land base of only 21,634 acres.

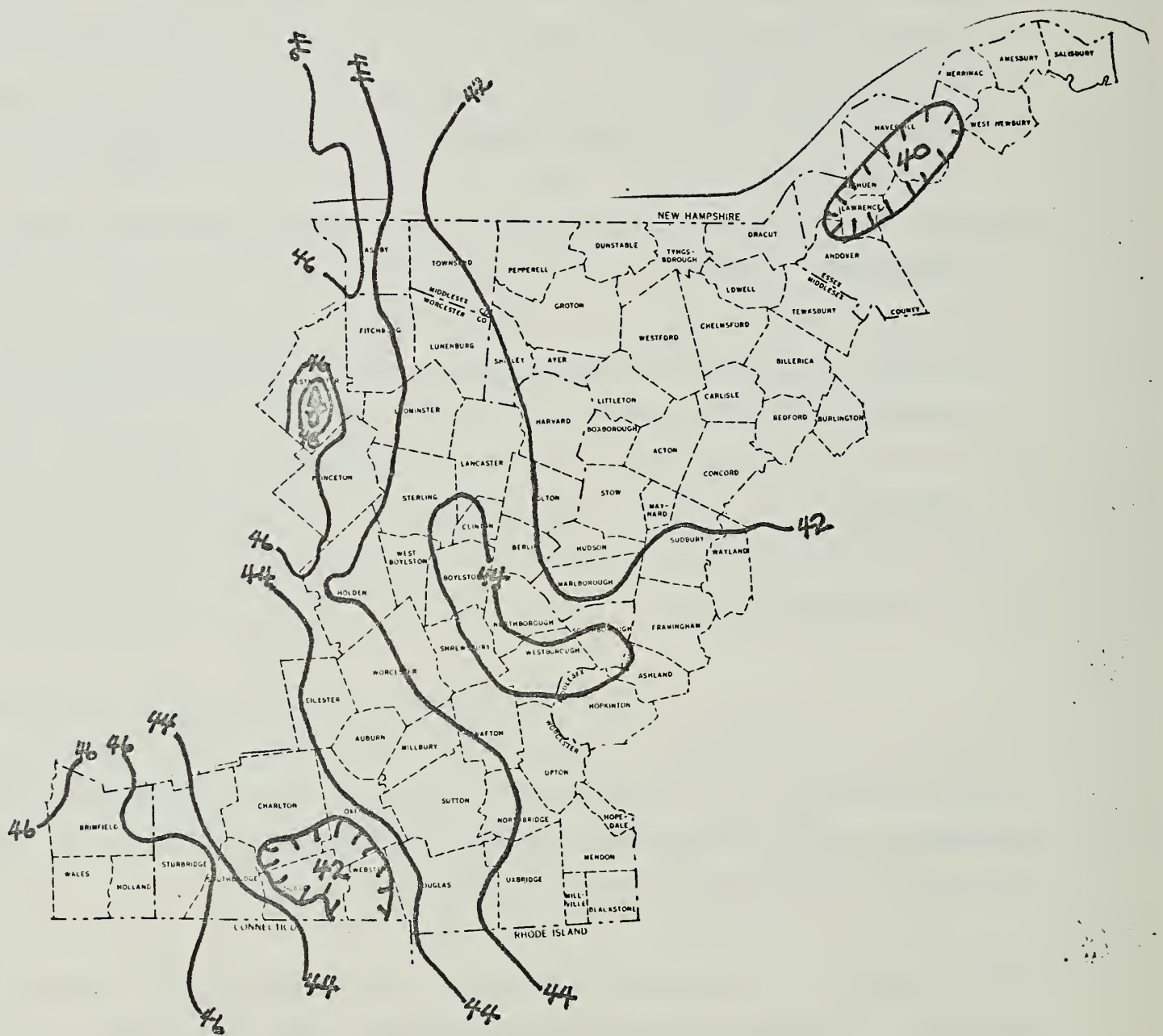


FIGURE 5.2

AVERAGE ANNUAL PRECIPITATION
(INCHES)

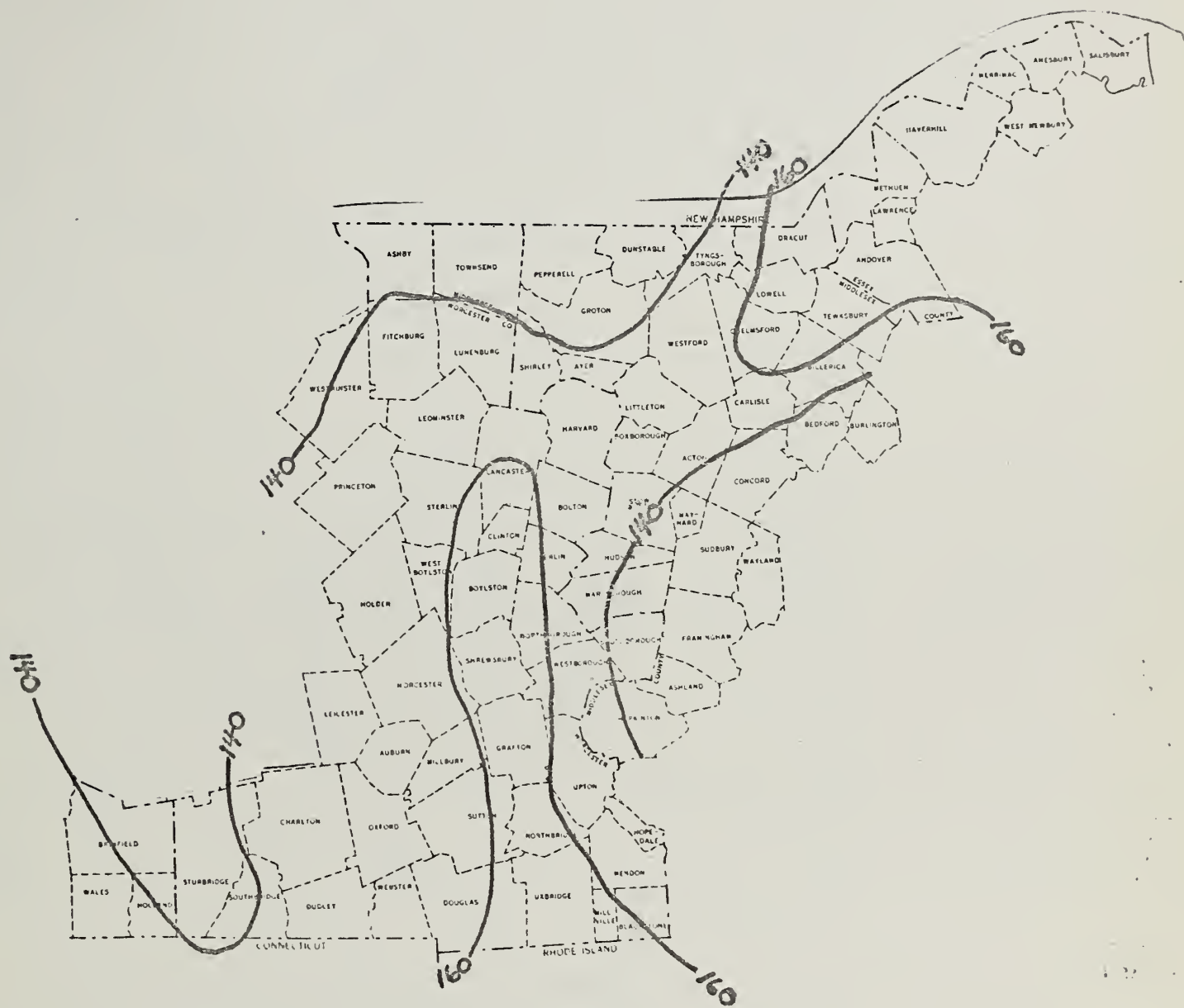


FIGURE 5.3

AVERAGE ANNUAL GROWING SEASON
(DAYS)

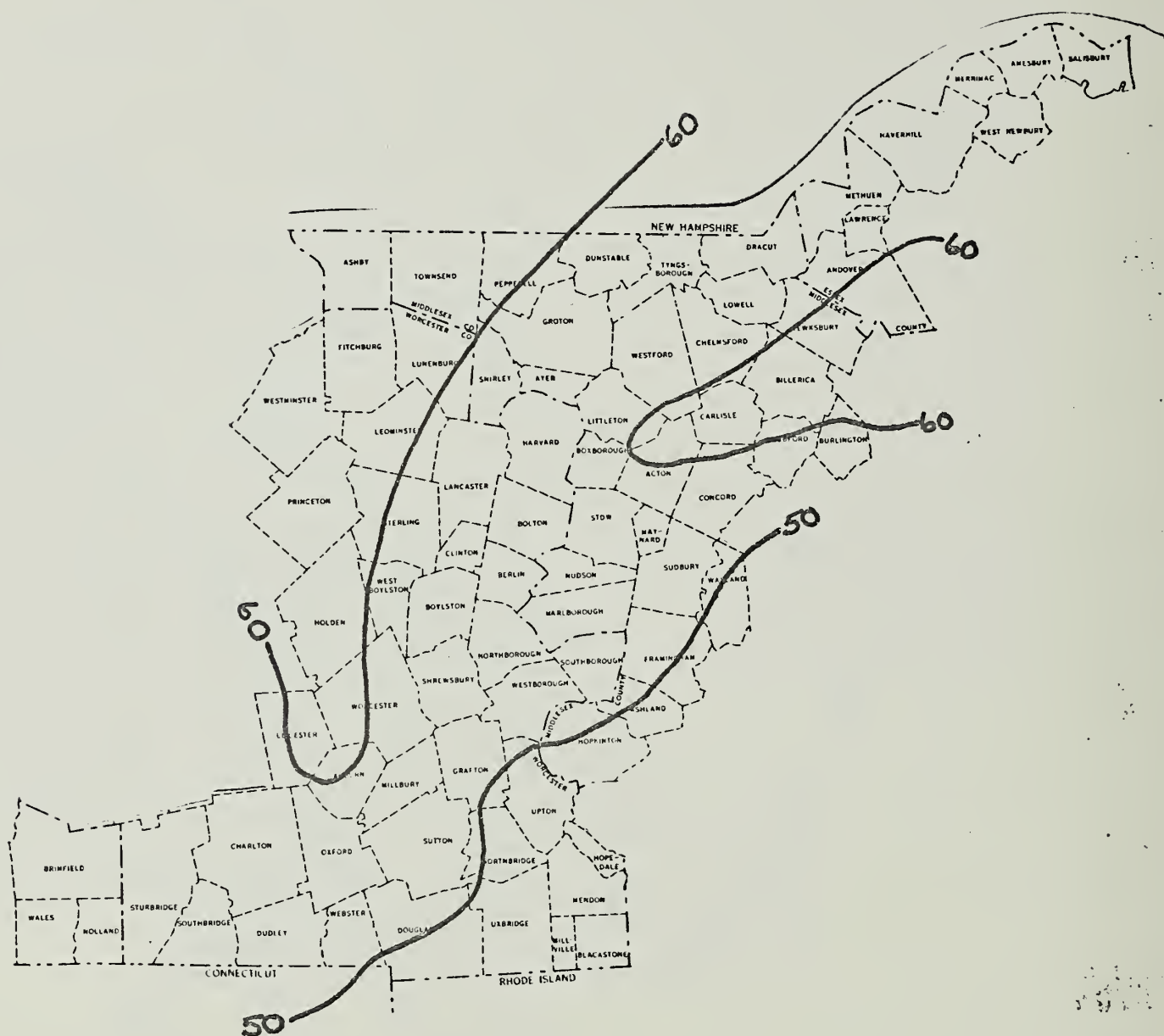


FIGURE 5.4

AVERAGE ANNUAL SNOWFALL
(INCHES)

TABLE 5.1
STREAM GAGE DATA

USCS Stream Gage Number	Location	Drainage Area (sq.mi.)	Period of Record	Average Flow C.F.S.	Minimum Flow J.F.S.	Date	C.F.S.	Maximum Flow C.S.M.	Date
01094400	Merrimac River Basin No. Nashua River @ Fitchburg	63.6	Oct. 1972 - current	-	24	Aug. 6, 1974	2,080	32.7	Dec. 21, 1973
01095500	Merrimac River Basin So. Branch Nashua @ Clinton	107.69	July 1896 - current	188	Flow diverted for MDC water supply				
01096000	Merrimac River Basin	62.8	Oct. 1949 - current	108	2	Sept. 7, 1965	4,010	63.9	Oct. 16, 1955
01096500	Squannacook River @ W. Groton	433	Oct. 1935 - current	528	1.1	Aug. 13, 1939	20,900	48.3	Mar. 20, 1936
01096910	Merrimac River Basin Nashua River @ E. Pepperell	1.54	June 1971 - current	-	0.02	Aug. 25, 1971	71	46.1	Mar. 22, 1972
01097000	Boulder Brook @ E. Bolton	116	July 1941 - current	181	0.2	Feb. 7, 1965	4,250	36.6	Aug. 20, 1955
01097300	Merrimac River Basin Assabet River @ Maynard	12.7	Occasional 1962 - 1963	17.7	0.02	Sept. 6, 1968	360	28.3	Mar. 19, 1968
01097500	Merrimac River Basin Nashoba Brook @ Acton	75.2	July 1963 - current	114	Flow diverted for MDC water supply				
01099500	Sudbury River @ Framingham	405	Jan. 1875 - current	457	4.0	Sept. 29, 1957	4,800	11.9	Mar. 22, 1968
01100000	Merrimac River Basin Concord River @ Lowell	4635	Oct. 1936 - current	7200	199	Sept. 23, 1923	173,000	37.3	Mar. 20, 1936
01100700	Merrimac River Basin Merrimac River @ Lowell	4.93	June 1923 - current	9.01	0.05	Sept. 5, 1963	211	42.8	Mar. 19, 1968
01109500	E. Meadow River @ Haverhill	31.3	Oct. 1962 - Sept. 1974	53.4	0.2	May 17, 1940	3,970	126.8	Aug. 19, 1955
01110100	Blackstone River Basin Kettle Brook @ Worcester	25.5	Aug. 1923 - current	41.4	0	Aug. 22, 1966	820	32.2	Aug. 20, 1955
01110500	Quinsigamond River @ N. Grafton	139	Oct. 1939 - current	245	2	Aug. 29, 1941	16,900	121.6	Aug. 20, 1955
01111200	Blackstone River Basin Blackstone River @ Northbridge	27.9	Oct. 1939 - current	43.7	1.1	Sept. 12, 1963	370	13.3	Mar. 26, 1968
01123600	West River @ Uxbridge	99.1	Mar. 1962 - current	158	7.3	Nov. 21, 1964	1,270	12.8	Feb. 6, 1973
01124350	Thames River Basin Quinebaug River @ Southbridge	31.0	Oct. 1962 - current	51.5	0	July 17, 1968	496	16.0	Mar. 20, 1962
01124750	French River @ Hodges Village	0.49	Mar. 1962 - current	1.08	0	1963 - 1965	125	255.1	Mar. 19, 1968
01125000	Thames River Basin Brown Brook @ Webster	85.3	Oct. 1962 - current	156	2	April 15, 1965	1,020	12.0	April 2, 1960

On the other hand, urban land use expanded from 77,804 acres in 1951 to 186,278 acres in 1971 (7.1 percent of the region in 1951, and 17.1 percent in 1971), an increase of 139 percent representing 108,474 acres.

Forestland acreage in the region decreased by 6,760 acres between 1951 and 1971. However, there were two substudy areas which experienced gains (Nashua - 6,060 acres; Thames - 2,981 acres). The remaining three substudy areas lost acreages ranging from 1,580 acres to 9,473 acres.

Table 5.2 summarizes the major changes in the various study areas.

TABLE 5.2 MAJOR LAND USE CHANGES, 1951-1971

Study Area	Agricultural Land (% Change)	Land (Acres)	Urban Land (% Change)	Land (Acres)	Forestland (%Change)	Land (Acres)
Merrimack	-54.4	-25,795	112.4	29,298	-8.8	-9,473
Nashua	-45.1	-22,698	140.3	18,481	3.1	6,060
Blackstone	-45.4	-12,789	88.8	15,603	-1.4	-1,580
SuAsCo	-59.7	-33,853	214.1	35,684	-3.3	-4,748
Thames	-34.1	-8,102	216.4	9,408	2.6	2,981
Central Region	-50.0	-103,237	139.4	108,474	-1.0	-6,760

Source: MacConnell, et al.

Table 5.3 summarizes the land resource base in the region and the shares of each land use category to the total land base by each substudy area for the years 1951 and 1971. It is important to note that the other land category is composed of the following subcategories as presented in MacConnell's et al data:

1. abandoned fields and abandoned orchards, most of which are reverting to forest or scrub brush;
2. gas, telephone, oil, or power line rights-of-way 100 feet or more maintained through wooded areas;
3. mining and waste disposal areas;
4. open or undeveloped land which is in the midst of or, adjacent to urban areas; and
5. lands used for recreational purposes.

Table 5.3

Central Region - Land Use

Acres, 1951 and 1971

	Cropland	Pasture	Agricul- tural Land 1 & 2	Forest	Wetland	Water	Ind/Com	Resid	Inst	Urban 6,7 & 8	Other	Total
Merrimac												
1951	17,598.	30,031.	47,429.	107,410.	11,370.	7,750.	3,153.	21,564.	1,342.	26,059.	10,693.	210,711.
1971	13,036.	8,598.	21,634.	97,937.	8,804.	8,739.	10,977.	41,405.	2,975.	55,357.	18,240.	210,711.
Change in acres	-4,362.	21,433.	-25,795.	-9,473.	-2,566.	989.	7,824.	18,841.	1,633.	29,298.	7,547.	
1950 share (%)	8.3	14.3	22.5	51.0	5.4	3.7	1.5	10.2	0.6	12.4	5.1	
1970 share (%)	6.2	4.1	10.3	46.5	4.2	4.1	5.2	19.2	1.4	26.3	8.7	
Change in % share	-2.1	10.2	-12.2	-4.5	-1.2	0.4	3.7	9.0	0.8	13.9	3.6	
Nashua												
1951	31,093.	19,181.	50,274.	196,603.	7,892.	9,806.	2,109.	9,375.	1,686.	13,170.	16,204.	293,949.
1971	16,893.	10,683.	27,576.	202,663.	4,382.	11,804.	3,966.	24,822.	2,863.	31,651.	15,873.	293,949.
Change in acres	-14,200.	-8,498.	-22,698.	6,060.	-3,510.	1,998.	1,857.	15,447.	1,177.	18,481.	-331.	
1950 share (%)	10.6	6.5	17.1	66.9	2.7	3.3	0.7	3.2	0.6	4.5	5.5	
1970 share (%)	5.7	3.6	9.4	68.9	1.5	4.0	1.3	8.4	1.0	10.8	5.4	
Change in % share	-4.9	-2.9	-7.7	2.0	-1.2	0.7	0.6	5.2	0.4	6.3	-0.1	
Blackstone												
1951	12,452.	15,743.	28,195.	109,600.	4,294.	4,906.	2,500.	13,755.	1,307.	17,562.	11,658.	176,215.
1971	9,867.	5,539.	15,406.	108,020.	3,583.	5,002.	5,452.	25,492.	2,221.	33,165.	11,039.	176,215.
Change in acres	-2,585.	-10,204.	-12,789.	-1,580.	-711.	96.	2,952.	11,737.	914.	15,603.	-619.	
1950 share (%)	7.1	8.9	16.0	62.2	2.4	2.8	1.4	7.8	0.7	10.0	6.6	
1970 share (%)	5.6	3.1	8.7	61.3	2.0	2.0	3.1	14.5	1.3	18.8	6.3	
Change in % share	-1.5	-5.8	-7.3	-0.9	-0.4	0.0	1.7	6.7	0.6	8.8	-0.3	
StuAsCo												
1951	29,655.	27,025.	55,680.	143,494.	12,001.	6,364.	1,686.	13,756.	1,042.	16,666.	12,862.	248,067.
1971	14,365.	8,462.	21,827.	138,746.	9,134.	7,478.	9,450.	40,243.	2,657.	52,350.	17,532.	248,067.
Change in acres	-15,290.	-18,563.	-33,853.	-4,748.	-2,867.	1,114.	7,582.	26,487.	1,615.	35,684.	4,670.	
1950 share (%)	12.0	10.9	22.8	57.8	4.8	2.6	0.8	5.5	0.4	6.7	5.2	
1970 share (%)	5.8	3.4	9.2	55.9	3.7	3.0	3.8	16.2	1.1	21.1	7.1	
Change in % share	-6.2	-7.5	-13.6	-1.9	-1.1	0.4	3.0	10.7	0.7	14.4	1.9	
Thames												
1951	5,517.	18,216.	23,733.	114,158.	4,324.	5,246.	469.	3,680.	198.	4,347.	11,506.	163,114.
1971	9,514.	6,117.	15,631.	117,139.	2,218.	5,933.	2,406.	10,579.	770.	13,755.	8,438.	163,114.
Change in acres	3,997.	-12,099.	-8,102.	2,981.	-2,106.	687.	1,937.	6,899.	572.	9,408.	-2,868.	
1950 share (%)	3.4	11.2	14.5	70.0	2.7	3.2	0.3	2.3	0.1	2.7	6.9	
1970 share (%)	5.8	3.8	9.6	71.8	1.4	3.6	1.5	6.5	0.5	8.4	5.2	
Change in % share	2.4	-7.4	-4.9	1.8	-1.3	0.4	1.2	4.2	0.4	5.7	-1.7	
Total												
Central												
1951	96,115.	110,196.	206,311.	671,265.	39,881.	34,072.	10,099.	62,130.	5,575.	77,804.	62,723.	1,092,056
1971	63,675.	39,399.	103,074.	664,505.	28,121.	38,956.	32,251.	142,541.	11,486.	186,278.	71,122.	1,092,056
Change in acres	-32,440.	-70,797.	-103,237.	-6,760.	-11,760.	4,884.	22,152.	80,411.	5,911.	108,474.	8,399.	
1950 share (%)	8.8	10.1	18.9	61.5	3.7	3.1	0.9	5.7	0.5	7.1	5.7	
1970 share (%)	5.8	3.6	9.4	60.8	2.6	3.6	3.0	13.1	1.1	17.1	6.5	
Change in % share	-3.0	-6.9	-9.5	-7.7	-1.1	0.5	2.1	7.4	0.6	10.0	0.8	

In 1971, there were 71,122 acres within the other land use category. The decrease in forestland would no doubt have been greater if it weren't for the fact that much land classified in the other category in 1951 entered the forestland category by 1971.

It should be noted that, when looking at the changes that have occurred, caution should be used. For example, increases in water acreage were due in part to the installation of water impoundments, but more accurate analysis of the 1971 aerial photos also explains some of the increase. Minimum size of plots categorized in 1951 was 10 acres; in 1971, the minimum size was decreased to 3 acres. Thus, certain rivers and streams that were categorized as something other than water in 1951 were categorized as water in 1971.

The wetland category also poses a problem. In 1952, beaver ponds, seasonally flooded flats and bogs were categorized as the dominant adjacent land use. In 1971, however, they were included within the wetland category. In both years of analysis, wooded swamps were included as forestland, since photo interpretation precluded doing otherwise. Thus, the wetland category should be considered as open wetlands. In summary, actual changes as listed in Table 5.3 should not be taken as gospel. In any case, the changes simply suggest the trends that have occurred in the land base for the 20-year period.

In terms of acreage changes, the most significant categories are agricultural land and urban land. As Table 5.2 shows, agricultural land decreased 103,237 acres, a drop of 50 percent. When it is considered that Massachusetts now imports approximately 85 percent of its food, a continuation of this trend is a rather disturbing thought. Much of the former agricultural acreage has gone into urban uses. From an agricultural perspective, although the actual conversion acreage may not be that large, there are a number of important ramifications.

From an economic viewpoint, statewide agricultural earnings, while amounting to over \$200 million, are quite insignificant relative to the total earnings in the state. Agricultural pursuits employ less than 1 percent of the labor force and contribute comparably to total personal income. It should be noted, however, when agricultural enterprises are considered within the goals and objectives of local or regional planning groups, the simple economic viewpoint is inadequate.

If we look at Table 5.3, the two study areas which experienced the greatest losses in agricultural land were the SuAsCo and the Merrimack. These losses are a direct result of population shifts from the near-in Boston residential area to those further out. The Blackstone study area experienced a similar decline primarily due to the influences of the Worcester Metropolitan area.

There are a number of factors which appear to aggravate the continuing decrease in agricultural land:

1. Zoning ordinances--most towns in the region have zoned agricultural land to permit residential use on lots of one acre or less, and in some cases, industrial and commercial use is also allowed. Most zoning regulations incorporate an implicit assumption that farming is a residual or temporary use which will be replaced by nonagricultural uses, and zoning often times is in direct opposition to the publicly professed land use objective of preserving agricultural land.

Section 81 of Chapter 41, General Laws, stipulates that for any development which will be placed upon frontage along already existing public roads, subdivision review is not required. Although recently introduced legislation has a requirement that any development on more than two lots would require subdivision approval, the fact that there is no minimum time frame incorporated into the act somewhat diminishes

its potential impact. The result is a large degree of strip development which creates the most expensive pattern for public services. Such development patterns also maximize the potential encroachment on agricultural land. For example, as development continues, farmer field operations taking place behind the strip may be subject to nuisance ordinances forced on the operator by the new residents who wield more political power. The indirect and direct impacts of zoning regulations seem to be diametrically opposed to the professed intent of preserving agriculture.

2. Relative to competing agricultural areas, especially those in truck farm type crops, Massachusetts' climate provides a relatively short growing season. This factor together with the distribution of soil groups, size of holdings, and labor costs, produces a comparative disadvantage. As Christensen pointed out, nearly three million acres were cleared and used for agriculture in 1860. Today most of this land is now growing trees. But even if this former cropland was brought back into production, the resulting food costs would be higher than they now are because of the expense of working the land and the relatively low yields:

"Plowing and tilling an acre of stony land has a much higher cost than plowing an acre of nonstony land and, when this extra cost is combined with lower yields, the resulting food produce has a high production cost per unit of yield."

3. A third factor that helps explain the loss of agricultural land is the fact that there are very few storage facilities in the state; thus, the advantages of bulk shipping from the food and feed crop exporting areas cannot be gained. As a result, the unit cost of transporting the necessary productive inputs are high and, consequently, the cost of raising livestock and crops are higher than in those areas which have adequate storage facilities.

For example, in 1945, poultry production was the most important source of farm income in Massachusetts (38.1 percent) as compared to 1974 when it amounted to approximately 13 percent of all agricultural income. This decline was brought about by the vast expansion of poultry enterprises in the DelMarVa Peninsula and areas south. The climatic difference is such that corn and soybeans, the major feed ingredients, grow prolifically in these southern areas. And when there are inadequacies in cropland area, the presence of large storage facilities permit bulk transportation of feed at minimal costs. As a result, the poultry areas of the south can produce chickens at a lower cost, while equalling or exceeding the quality of the Massachusetts products.

4. A fourth reason which explains the loss of agricultural land is two-fold: higher transportation rates and a lack of a coordinated marketing system. As Platt, et al. diagrammed, Franklin and Hampshire Counties are the major agricultural areas in the state. Most of this area which borders the Connecticut River is in vegetable crop production. But the lack of consistent product quality tied with a sporadic supply schedule has precluded the development of vegetable processing industry or a well coordinated fresh-market system. As a result, other regions in the country, namely Florida and California with their longer growing seasons, crop varieties, and modern processing plants, supply a great deal of the fresh and processed vegetable products to Massachusetts.

In 1973, the Massachusetts General Court enacted Chapter 61A as a step in curbing the loss of agricultural land. This act provided for the assessment of agricultural land at a value based upon its agricultural or horticultural uses. Although a rigorous assessment of the impact of this act has not been undertaken, the general consensus is that it has been of minimal effectiveness in curbing the loss of agricultural land. The primary explanation for this result is that there was defacto agricultural assessment prior to the passage of the act. As Barlowe and Alter stated:

"How far use-value assessment programs can go in protecting agricultural and open space land depends largely on the emphasis given to the current use-protection objective.

"Landowners have a natural economic incentive for favoring taxing arrangements that provide them with benefits and still leave them with the option of developing or selling their lands. A protection policy, in contrast, calls for tight declassification procedures that discourage or prevent withdrawals once lands have been accepted for (agricultural assessment) classification.

"These two objectives are in conflict. Programs that emphasize the first objective provide little protection for existing land uses while those that emphasize the protection goal offer little incentive for owner participation. Considerable emphasis has been given to protectionist goals in several laws enacted in the past decade, but even the most restrictive of these involves elements of compromise between the two objectives.

"Recognition of these factors prompts the conclusion that, by itself, use-value assessment cannot provide more than a partial answer to the farmland and open space preservation problem. Its chief merit lies in the role it can play in buying time, particularly in semirural areas, for state and local governments to seek and enact supplemental programs to protect agricultural and open space lands."

Defacto agricultural assessment has precluded the agricultural assessment act from being an effective means, of preserving agricultural and horticultural lands. However, the situation has recently changed since each city and town must now assess property values at 100 percent of market value. Such an assessment would preclude defacto assessments and, therefore, the potential effectiveness of the agricultural assessment act may increase substantially.

To further the potential of agricultural preservation, the General Court enacted a development rights bill which authorizes cities and towns to purchase the development rights to agricultural land. Recently, another bill was signed into law providing for state acquisition of farmland development rights as "agricultural preservation restrictions" with an initial \$5 million funding for a pilot program. This restriction program can be used in conjunction with town based efforts under the first named legislation.

The effectiveness of a development rights program may also be limited, because land is merely one of many productive inputs. In a recent investigation trying to explain the loss of agricultural land, the variables having to do with increased population growth, increasing taxes, and increased urbanization were insignificant in explaining the loss. This strongly suggests that the agricultural demise results from low net income to the agricultural community. To the extent that the development rights program supplies additional capital to the farmers and, to the extent that such capital is invested in cost reducing measures, then the development rights program may have a positive impact.

5.2B Agricultural Land Study

The U.S. Department of Agriculture is concerned about any action that tends to impair the productive capacity of American agriculture. The continuing loss of farmland in the Central Region is such an action. Nationwide, the SCS has an Inventory and Monitoring Program to inventory and keep current, prime and unique farmland acreage. Farmlands that are of statewide or local importance for producing crops are also identified. The nation needs to know the extent and location of the best land for producing food, feed, fiber, and forage.

The first phase of the farmland inventory will be conducted in those counties which have published soil surveys available. In the Central Region, no soil surveys have been completed, however, northern Essex County is pending publication. Results of the nationwide Land Inventory and Monitoring Program is not expected in the Central Region until the early 1980s.

Three categories of farmland are being inventoried:

1. Prime Farmland--Prime farmland is land best suited for producing food, feed, forage, and fiber. In addition the land could be used for cropland, pastureland, rangeland, forestland, or other land, but not urban, builtup land, or water. It has the soil

quality, growing season, and moisture supply needed to produce sustained high yields of crops economically, when treated and managed (including water management) according to modern farming methods.

2. Unique farmland--Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality and/or high yields of a specific crop when treated and managed according to modern farming methods. Examples of such crops in Massachusetts are cranberries and fruit orchards.

Unique farmland has the following characteristics:

- a. It is used for a specific high-value food or fiber crop.
 - b. It has a moisture supply that is adequate for the specific crop; the supply is from stored moisture, precipitation, or a developed irrigation system.
 - c. It combines favorable factors of soil quality, growing season, temperature, humidity, air drainage, elevation, aspect, or other conditions, such as, nearness to market, that favor the growth of a specific food or fiber crop.
3. Additional Farmland of Statewide and Local Importance--This is land, in addition to prime and unique farmlands, that is of statewide and local importance for the production of food, feed, fiber, and forage crops. Criteria for defining and delineating this land are to be determined by state and local personnel familiar with the specific needs of the region. These lands include some of those commonly utilized for pasture and hay.

To illustrate the dramatic irreversible loss of farmland to urbanization in the Central Region, the Massachusetts Water Resources Study has analyzed data for 21 towns. Basic data was prepared in a manner which can make it

useful to a variety of state and local agencies in efforts to protect existing farmland.

Towns were selected to represent a geographic distribution in the region. A prerequisite for inclusion of a town was the availability of a published soil survey for the community. Communities selected are shown on Figure 5.5.

A base map for the community was prepared at scale 1:24,000 (1 inch = 2,000 feet), using the U.S. Geological Survey topographic maps. Detailed soils data was adjusted to the base map and a transparent mylar overlay of the detailed soils map prepared. Another mylar overlay was constructed which indicated all prime farmland and farmland of state and local importance.

Using a transparent copy of this farmland soils overlay, land use data was added, using the 1971 Massachusetts Map Down maps. Existing farming was mapped wherever it occurred in the town. In addition, land uses were mapped for all areas of farmland soil.

The data contained in this combined farmland soils-land use overlay was measured and summarized. Results are presented in Tables 5.4 to 5.8. Some interesting conclusions can be drawn from this study of farmland in the region.

First, land being farmed represents a very small percentage of the total town area. It ranges from 20.7 percent of the area of West Newbury to only 4.4 percent of the town of Douglas.

Towns sampled were selected because they had more prime farmland soil, but even in these towns prime farmland soils on the average constitutes less than 14 percent of the town area.

Approximately one-fourth of the prime farmland has been lost through urbanization. The remaining is divided rather equally between forestland and farmland.

Figure 5.5

COMMUNITIES STUDIED IN
AGRICULTURAL LAND STUDY

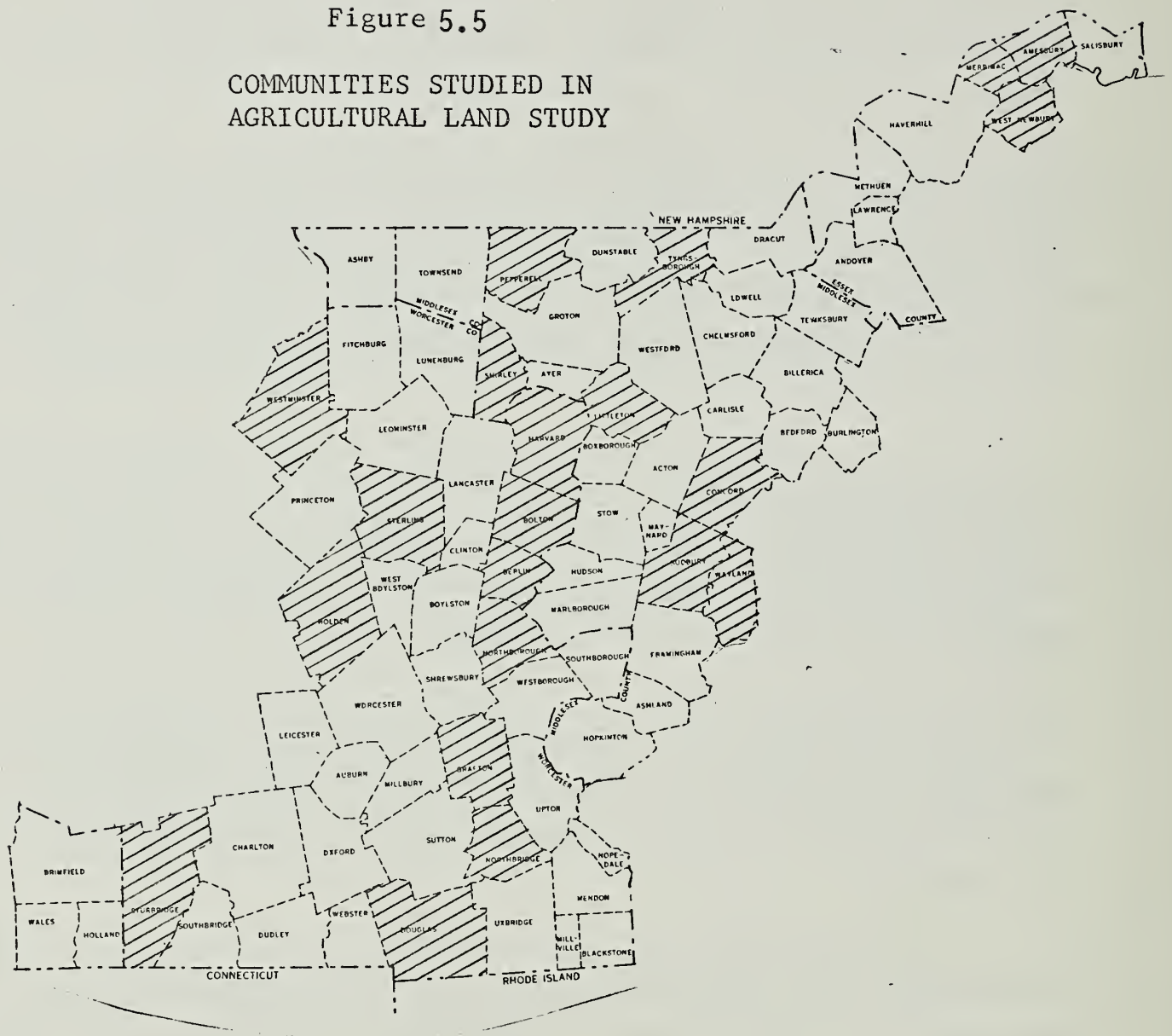


Table 5.4

Existing Farmland

Community	Cropland	Pasture	Orchard	Total
	Acres (Percent of Town Area)			
Amesbury	857 (9.7)	526 (5.9)	19 (0.2)	1,402 (15.8)
Berlin	304 (3.6)	824 (9.8)	100 (1.2)	1,228 (14.6)
Bolton	793 (6.2)	557 (5.1)	513 (4.0)	1,963 (15.4)
Concord	1,692 (10.2)	687 (4.1)	2 1/	2,381 (14.4)
Douglas	728 (3.0)	330 (1.3)	11 1/	1,069 (4.4)
Grafton	1,797 (12.2)	597 (4.1)	39 (0.3)	2,433 (16.6)
Harvard	963 (5.6)	308 (1.8)	693 (4.0)	1,964 (11.4)
Holden	569 (2.5)	569 (2.5)	4	1,142 (4.9)
Littleton	1,059 (9.3)	724 (6.4)	189 (1.7)	1,972 (17.4)
Merrimac	570 (10.0)	191 (3.4)	29 (0.5)	790 (13.9)
Northborough	353 (3.0)	789 (6.7)	227 (1.9)	1,369 (11.6)
Northbridge	685 (5.9)	177 (1.5)	3 1/	865 (7.4)
Pepperell	1,473 (10.0)	1,149 (7.8)	114 (0.8)	2,736 (18.6)
Shirley	370 (3.8)	460 (4.8)	57 (0.6)	887 (9.2)
Sterling	2,541 (12.6)	756 (3.7)	671 (3.3)	3,968 (19.7)
Sturbridge	661 (2.4)	416 (1.7)	58 (0.2)	1,135 (4.5)
Sudbury	1,400 (8.9)	356 (2.3)	5 1/	1,761 (11.2)
Tyngsborough	463 (4.1)	209 (1.9)	19 (0.2)	691 (6.1)
Wayland	582 (5.7)	434 (4.3)	1 1/	1,016 (10.0)
Westminster	345 (1.4)	953 (4.0)	11	1,309 (5.5)
West Newbury	853 (9.0)	861 (9.1)	257 (2.7)	1,971 (20.7)

1/ Less than 0.1 percent.

Table 5.5

Prime Farmland Soils

Community	Land Use						Total *
	Cropland	Pasture	Orchard	Forest	Available	Urban	
	Acres (Percent of Prime Soils in this Land Use)						
Amesbury	388 (18.9)	209 (10.1)	17 (0.8)	553 (26.9)	119 (5.8)	766 (37.3)	2,052 (23.1)
Berlin	200 (16.8)	271 (22.8)	30 (2.5)	293 (24.6)	145 (12.2)	250 (21.0)	1,189 (14.1)
Bolton	406 (19.2)	211 (10.0)	287 (13.6)	752 (35.6)	161 (7.6)	293 (13.9)	2,110 (16.5)
Concord	391 (32.8)	79 (6.6)	0	413 (34.6)	78 (6.5)	231 (19.4)	1,192 (7.2)
Douglas	270 (18.7)	69 (4.8)	1 (0.1)	638 (44.1)	103 (7.1)	364 (25.2)	1,445 (5.9)
Grafton	790 (32.5)	126 (5.2)	15 (0.6)	557 (23.0)	310 (12.7)	634 (26.1)	2,432 (16.6)
Harvard	390 (20.8)	71 (3.8)	271 (14.4)	772 (41.1)	140 (7.4)	233 (12.4)	1,878 (10.9)
Holden	239 (9.5)	170 (6.8)	3 (0.1)	1,505 (60.0)	62 (2.5)	526 (21.0)	2,505 (10.8)
Middleton	409 (32.2)	165 (13.0)	91 (7.2)	219 (17.2)	111 (8.7)	274 (21.6)	1,269 (11.2)
Uxbridge	251 (23.8)	83 (7.9)	9 (0.8)	416 (39.5)	65 (6.2)	228 (21.7)	1,052 (18.5)
Northborough	247 (9.1)	333 (12.3)	115 (4.2)	660 (24.3)	235 (8.7)	1,123 (41.4)	2,713 (22.9)
Northbridge	290 (24.6)	42 (3.6)	0	383 (32.6)	112 (9.5)	349 (29.7)	1,176 (10.0)
Pepperell	659 (32.2)	360 (17.6)	63 (3.0)	604 (29.6)	77 (3.8)	278 (13.6)	2,041 (13.8)
Shirley	130 (14.8)	64 (7.3)	6 (0.6)	443 (50.3)	80 (9.1)	156 (17.7)	879 (9.1)
Sterling	1,041 (34.0)	137 (4.5)	213 (7.0)	1,136 (37.2)	228 (7.5)	298 (9.8)	3,053 (15.1)
Sturbridge	222 (12.8)	57 (3.3)	11 (0.6)	879 (50.5)	192 (11.0)	379 (21.8)	1,740 (6.9)
Sudbury	597 (28.0)	109 (5.1)	0	875 (41.0)	178 (8.3)	373 (17.5)	2,132 (13.6)
Tyngsborough	202 (27.4)	16 (2.2)	3 (0.4)	298 (40.4)	25 (3.4)	194 (26.3)	738 (6.6)
Wayland	196 (14.0)	96 (6.9)	0	491 (35.0)	79 (5.6)	539 (38.5)	1,401 (13.8)
Westminster	101 (11.1)	172 (18.9)	0	362 (39.8)	45 (4.9)	230 (25.3)	910 (3.8)
West Newbury	537 (20.6)	354 (13.6)	121 (4.6)	1,017 (39.0)	184 (7.0)	396 (15.2)	2,609 (27.4)

*Percent of the town in Prime Farmland Soil.

Table 5.6
Soils of State and Local Importance for Farming

Community	Cropland	Pasture	Orchard	Land Use		Urban	Total
				Forest	Available		
				Acres			
(Percent of State and Local Important Soils in this Use)							
Amesbury	191 (8.6)	112 (5.0)	2 (0.1)	1,205 (54.1)	76 (3.4)	640 (28.8)	2,226 (25.1)
Berlin	71 (4.4)	313 (19.5)	31 (1.9)	927 (57.7)	94 (5.8)	171 (10.6)	1,607 (19.1)
Bolton	116 (4.0)	187 (6.4)	96 (3.3)	1,928 (66.2)	212 (7.3)	373 (12.8)	2,913 (22.8)
Concord	797 (11.3)	329 (4.7)	2 1/	3,377 (47.9)	430 (6.1)	2,114 (30.0)	7,049 (42.6)
Douglas	304 (10.2)	149 (5.0)	5 (0.2)	2,179 (73.1)	111 (3.7)	233 (7.8)	2,981 (12.2)
Grafton	622 (13.9)	339 (7.6)	11 (0.2)	1,940 (43.4)	425 (9.5)	1,131 (25.3)	4,468 (30.5)
Harvard	204 (7.9)	75 (2.9)	114 (4.4)	1,641 (64.0)	88 (3.4)	441 (17.2)	2,563 (14.9)
Holden	196 (3.9)	194 (3.8)	1	3,292 (65.2)	133 (2.6)	1,234 (24.4)	5,050 (21.9)
Littleton	434 (14.3)	272 (9.0)	65 (2.1)	1,267 (41.8)	249 (8.2)	743 (24.5)	3,030 (26.7)
rimac	189 (9.8)	48 (2.5)	11 (0.5)	1,333 (69.1)	92 (4.8)	256 (13.2)	1,929 (34.0)
Northborough	69 (2.8)	184 (7.4)	29 (1.1)	1,272 (50.8)	166 (6.6)	781 (31.2)	2,501 (21.1)
Northbridge	157 (5.8)	64 (2.3)	0	1,673 (61.3)	150 (5.5)	683 (25.0)	2,727 (23.3)
Pepperell	459 (9.7)	364 (7.7)	25 (0.5)	3,170 (66.8)	185 (3.9)	541 (11.4)	4,744 (32.2)
Shirley	148 (4.0)	225 (6.1)	22 (0.6)	2,546 (68.7)	207 (5.6)	557 (15.0)	3,705 (38.5)
Sterling	911 (14.6)	269 (4.3)	337 (5.4)	3,598 (57.8)	401 (6.4)	707 (11.4)	6,223 (30.8)
Sturbridge	199 (7.6)	111 (4.2)	30 (1.1)	1,590 (60.8)	266 (10.2)	417 (15.9)	2,613 (10.4)
Sudbury	608 (9.0)	166 (2.5)	5 (0.1)	3,288 (48.9)	476 (7.1)	2,180 (32.4)	6,725 (42.9)
Tyngsborough	177 (5.1)	98 (2.8)	11 (0.3)	2,167 (62.0)	181 (5.2)	857 (24.5)	3,491 (31.1)
Wayland	314 (9.8)	232 (7.3)	0	1,128 (35.4)	202 (6.3)	1,314 (41.2)	3,190 (31.4)
Westminster	132 (3.6)	443 (12.1)	0	2,376 (65.1)	224 (6.1)	476 (13.0)	3,651 (15.3)
West Newbury	109 (7.0)	220 (14.1)	69 (4.4)	923 (59.1)	126 (8.1)	115 (7.4)	1,562 (16.4)

1/ Less than 0.1 percent.

Table 5.7

Prime Farmland Soils and Soils of State and Local Importance for Farming

Community	Land Use						Total
	Cropland	Pasture	Orchard	Forest	Available	Urban	
	Acres (Percent of Prime Farmland Soils and Soils of State and Local Importance in this Land Use)						
Amesbury	579 (13.5)	321 (7.5)	19 (0.4)	1,758 (41.0)	195 (4.6)	1,406 (32.9)	4,278
Berlin	271 (9.7)	584 (20.9)	61 (2.2)	1,220 (43.6)	239 (8.5)	421 (15.0)	2,796
Bolton	522 (10.4)	398 (7.9)	383 (7.6)	2,680 (53.4)	373 (7.4)	666 (13.3)	5,022
Concord	1,188 (14.4)	408 (5.0)	2 1/	3,790 (46.0)	508 (6.2)	2,345 (28.4)	8,241
Douglas	574 (13.0)	218 (4.9)	6 (0.1)	2,817 (63.6)	214 (4.8)	597 (13.5)	4,426
Grafton	1,412 (20.5)	465 (6.7)	26 (0.4)	2,497 (36.2)	735 (10.6)	1,765 (25.6)	6,900
Harvard	594 (13.4)	146 (3.3)	385 (8.7)	2,413 (54.3)	228 (5.1)	674 (15.2)	4,440
Holden	435 (5.8)	364 (4.8)	4 1/	4,797 (63.5)	195 (2.6)	1,760 (23.3)	7,555
Littleton	843 (19.6)	437 (10.2)	156 (3.6)	1,486 (34.6)	360 (8.4)	1,017 (23.6)	4,299
rimac	440 (14.8)	131 (4.4)	20 (0.6)	1,749 (58.7)	157 (5.3)	484 (16.2)	2,981
Northborough	316 (6.1)	517 (9.9)	144 (2.8)	1,932 (37.1)	401 (7.7)	1,904 (36.5)	5,214
Northbridge	447 (11.4)	106 (2.7)	0	2,056 (52.7)	262 (6.7)	1,032 (26.4)	3,903
Pepperell	1,118 (16.5)	724 (10.7)	88 (1.3)	3,774 (55.6)	262 (3.9)	819 (12.1)	6,785
Shirley	278 (6.1)	289 (6.3)	28 (0.6)	2,989 (65.2)	287 (6.3)	713 (15.6)	4,584
Sterling	1,952 (21.0)	406 (4.4)	550 (5.9)	4,734 (51.0)	629 (6.8)	1,005 (10.8)	9,276
Sturbridge	421 (9.7)	168 (3.9)	41 (0.9)	2,469 (56.7)	458 (10.5)	796 (18.3)	4,353
Sudbury	1,205 (13.6)	275 (3.1)	5 1/	4,163 (47.0)	654 (7.4)	2,553 (28.8)	8,855
Tyngsborough	379 (9.0)	114 (2.7)	14 (0.3)	2,465 (58.3)	206 (4.9)	1,051 (24.8)	4,229
Wayland	510 (11.1)	328 (7.1)	0	1,619 (35.2)	281 (6.1)	1,853 (40.4)	4,591
Westminster	233 (5.1)	615 (13.5)	0	2,738 (60.0)	269 (5.9)	706 (15.5)	4,561
West Newbury	646 (15.5)	574 (13.8)	190 (4.6)	1,940 (46.5)	310 (7.4)	511 (12.2)	4,171

1/ Less than 0.1 percent.

Table 5.8

"Other"^{1/} Soils Being Farmed

Community	Cropland	Pasture	Orchard	Total & (%) of TownArea	Percent of Existing Farmland Located on "Other Soils"
	Acres				
Amesbury	278	205	0	483 (5.4)	34.4
Berlin	33	240	39	312 (3.7)	25.4
Bolton	271	259	130	659 (5.1)	33.6
Concord	504	279	0	783 (4.7)	32.9
Douglas	154	112	5	271 (1.1)	25.3
Grafton	385	132	13	530 (3.6)	21.8
Harvard	368	162	308	838 (4.6)	42.7
Holden	134	205	0	339 (1.5)	29.7
Littleton	216	287	33	536 (4.7)	27.2
Uxbridge	130	60	9	199 (3.5)	25.2
Northborough	37	270	83	390 (3.3)	26.5
Northbridge	238	71	3	312 (2.7)	36.1
Pepperell	355	425	26	806 (5.5)	29.4
Shirley	92	171	29	292 (3.0)	32.9
Sterling	589	350	121	1,060 (5.2)	26.7
Sturbridge	240	248	17	505 (2.0)	44.4
Sudbury	195	80	0	275 (1.8)	15.6
Tyngsborough	84	95	5	184 (1.6)	26.6
Wayland	71	106	0	177 (1.7)	17.4
Westminster	112	338	11	461 (1.9)	35.2
West Newbury	207	287	67	561 (5.9)	28.5

^{1/} "Other" soils are all soils except those classified as prime farmland soils or soils of state and local importance for farming.

^{2/} Percentage excludes cranberry bogs which are unique farmlands.

For soils of state and local importance, many of the same conclusions are evident: (a) these soils constitute about 30 percent of the town area; (b) a small percentage of land is being farmed with a great percentage used for urban land; (c) forestland is the dominant land use.

John Foster of the Department of Food and Resource Economics, University of Massachusetts, undertook a study similar to that which has been described above. In Foster's study, a sample of 26 towns was examined to determine the changes that occurred on agricultural land between 1951 and 1971. His findings are very similar to those enumerated above: 42 percent of the better agriculture soils are in forestland because of previous reversion, and urban land is found on 12 percent of these soils. His sample of 26 towns differed somewhat in that he chose only those towns with large agricultural areas relative to urban areas. As a result, his findings showed that in 1971, intensive agriculture (tilled land, orchard and nursery uses) was found on 25 percent or 119,000 acres of the better agricultural soils in the state.

Foster also developed a data base to show how agricultural land uses changed in the state between 1951 and 1971. He divided the acres of land tilled in 1971 into three soil productivity groups: "best", "good", and "poor." Approximately half of the state's tilled land was found on soils classified as "best" for agriculture, and another third was found on moderately good soils. Between 1951 and 1971, 5,900 acres per year were lost from tilled agricultural land to nonagricultural uses. Of this amount, 1,700 acres were classified as "best" agricultural land and went into the following uses: 400 acres became abandoned, 900 acres moved into urban uses, 200 acres became forested, and another 200 acres went into other uses (primarily recreation, but also includes mining, waste disposal, and wetlands). Another 1,500 acres were classified as "moderately" good agricultural soil and went into the following uses: 400 acres became abandoned, 700 acres went to urban uses, 200 acres went to forest uses, and another 200 acres went to other uses. A total of 56,000 acres went from tilled agricultural land of all types to

urban uses between 1951 and 1971, and 32,000 acres of that amount were "best" and "moderate" agricultural land. In summary, almost half of the agricultural land that went into nonagricultural uses was relatively good productive agricultural land. It must also be recognized that there were 84,000 acres of best and moderate agricultural land that were abandoned between 1951 and 1971. This acreage, unless committed to another use, will also revert to forestland.

Maps and data were developed for each of the towns studied through a cooperative agreement between the Soil Conservation Service, United States Department of Agriculture, and the Massachusetts Agricultural Experiment Station University of Massachusetts. Soils information was taken from field surveys of the Soil Conservation Service and all maps corrected to USGS quad sheet base. Copies of this data are expected to be made available to those towns studied in a packet form. Plans for sampling additional towns for other studies are proposed. To assist communities in assessing the status of their agricultural resource base, the Soil Conservation Service can provide a limited number of transparent overlays of the data compiled for this agricultural land study. The map data can be helpful in visualizing the extent of agricultural soils, existing agricultural enterprise, and in predicting future agricultural impacts of urban growth. The maps should be useful to planning boards, zoning boards of appeal, and conservation commissions. They are especially useful to communities about to embark on measures designed to protect their agricultural resources.

To illustrate the types of data available and the scope of information contained therein, a map has been prepared for the town of Sterling and printed as Figure 5.6 of this report. This map is the combination of three overlays and is intended to publicize the data available in the 21 communities sampled. Several other combinations or permutations of the basic overlays are possible depending on the needs of the community. Interested town officials should direct their requests to the local Conservation District.

Figure 5.6

MAP

Town of Sterling

(Fold out Map)

Shows:

Quad Base

Prime Agricultural Land (yellow)

State and Locally Important Land (green)

Land Use on Prime & Important Lands

All Existing Agricultural Land

5.2C Forestland

Forestland provides economic, environmental and social benefits. These benefits are in the form of wood products, water, wildlife, forage and recreation. The types and amounts of benefits produced from forestland are determined by the owners, subject to factors such as location, land productivity, and land conditions of site and soil. The owners can, for example, use their land for wood products, recreation and forage, and within limitations determine the mix of these benefits. They can also manage their properties to enhance water and wildlife benefits, even though these benefits transcend ownership boundaries.

Data on forestland ownership, number of acres owned, and reasons for ownership can be useful in drawing conclusions on the forestland resource base, and its potential outputs and benefits.

In the region, 664,505 acres are classed as forestland. Approximately 89 percent of this is in private ownership, which includes individuals, partnerships and corporations. Privately owned lands are usually not open to the general public. Eleven percent of the forestland is in public ownership, which includes state, local and federal governments. Publicly owned lands are usually open for public use, with stated exceptions.

The commercial forestland in the Central Region is owned in various sized tracts. An estimated 65 percent of the owners own 9 or fewer acres (see Table 5.9). A study by Kingsley of commercial forest landowners in Massachusetts shows that 4 percent of the owners control 10 percent of the commercial forestland for timber production. Fifty-seven percent of the owners control 45 percent of the land for investments or as part of their residences. The remaining 39 percent of commercial forestland is used in many diverse ways. Forestland ownership is shown in Table 5.10.

Kingsley estimated that 56 percent of the privately owned commercial forestland in southern New England (Massachusetts, Connecticut and Rhode Island) is available for the cutting of wood products. Using this percentage on

the 664,505 acres of available forestland in the Central Region indicates that 372,000 acres are available for the cutting of wood products.

TABLE 5.9 OWNERSHIP OF COMMERCIAL FORESTLAND BY SIZE CLASS, NUMBER OF OWNERS, AND ACRES OWNED 1/

<u>SIZE CLASS</u> (acres)	<u>OWNERS</u> (percent)	<u>ACRES OWNED</u> (percent)
1-9	65	7
10-19	10	6
20-49	11	17
50-99	8	24
100-199	5	27
200-499	1	9
500+	neg.	10

1/Derived from unpublished data on forestland ownership in Massachusetts, Northeastern Forest Experiment Station, Upper Darby, Pennsylvania.

TABLE 5.10 REASONS FOR OWNING FORESTLAND BY NUMBER OF OWNERS AND ACREAGE OWNED, MASSACHUSETTS

<u>REASON</u>	<u>OWNERS</u> (percent)	<u>ACREAGE OWNED</u> (percent)
Land investment	16	19
Recreation	16	21
Timber Production	4	10
General farm use	9	12
Part of residence	41	26
Other	<u>14</u>	<u>12</u>
Total	100	100

Source: Kingsley, op cit

5.3 INLAND FLOODING

In the area of flooding, the Massachusetts Water Resources Study has focused on inland flooding only. Although damage from tidal flooding occurs in the northeastern part of the region, there are no viable options available through USDA programs to reduce the damage. In fact, there are few alternatives to reduce tidal damage except the relocation of flood prone development. The National Flood Insurance Program, with its restriction on development of flood prone areas, will tend to limit future increases in coastal flood damage, but the existing damageable property will remain in peril.

The Massachusetts Coastal Zone Management Program has established a set of 38 policies for the coastal zone which includes five coastal hazard policies. These five are:

- Policy (8) Discourage further growth and development in hazardous areas and preserve natural buffers throughout the coastal zone.
 - a. Restrict new development in identified V and E zones and in barrier beach, sandy beach, primary dune, and salt marsh Significant Resource Areas to the permitted uses defined under Policy 1, Marine Environment section.
 - b. Condition new development in contiguous upland areas within a zone extending landward to 100 feet inland of the limit of the 100-year flood, especially within designated areas for Preservation or Restoration to ensure that existing hazards are not exacerbated and that the proposed uses or activities are appropriate in light of the risks of damage.
 - c. Ensure that development proposed to be located in inter-tidal areas or offshore in coastal water bodies will not exacerbate existing erosion or flooding hazards in adjacent or downcoast areas.

- d. Encourage and support local flood plain zoning and other management of hazardous areas in all coastal towns.

Policy (9) Ensure that state and federally funded public works projects proposed for location within the 100-year coastal flood plain will:

- a. not exacerbate existing hazards or damage natural buffers,
- b. be reasonably safe from flood and erosion related damage, and
- c. not promote growth and development in damage prone to buffer areas, especially in undeveloped areas of APR's.

Policy (10) Acquire undeveloped hazard prone areas for conservation or recreation use.

Policy (11) Provide funding and technical assistance for the restoration and stabilization of foreshore and shore areas in hazardous zones using nonstructural measures.

- Policy (12) a. Implement federal or state structural solutions to protect property and lives only when there will be widespread public benefits and minimal adverse environmental effects.
- b. Approve permits for private flood or erosion control projects only when it has been determined that there will be no adverse effects on adjacent properties or downcoast areas.

Major inland floods in the region have been the result of hurricane storms which dump great volumes of water over a 2 or 3-day period or late winter rains which fall on frozen ground or snow, resulting in relatively large

runoff volumes. The larger recent hurricane storms of September 17-22, 1938 and August 17-20, 1955 caused extensive flooding and damage throughout the region. Recent late winter storms which caused extensive inland flooding were in March 17-20, 1936 and March 17-20, 1968. In the Thames and Assabet River Basins, the Diane hurricane flood of August 1955 remains the largest recorded flow. For the other basins in the region, however, the storms of March 1968, September 1938 or March 1936 produced record flood discharges. The 1968 and 1936 floods were caused by heavy rains on ice and snow. For most basins these flows were the greatest since at least 1886, the year of another great winter flood.

The hurricane storm of August 17-20, 1955 produced from 4 to 17 inches of rainfall in the region, while the late winter storm of March 17-20, 1968 produced from 2 to 5 inches of rain in the region. Peak flows however, were comparable in many basins. This shows the dominating effect of existing conditions when a storm occurs.

The isohyetal map (Figure 5.7) shows the precipitation which occurred during the "Hurricane Diane" storm of August 17-20, 1955. This information was taken from U.S. Weather Bureau, Technical Paper No. 26, Hurricane Rains and Floods of August 1955 Carolinas to New England.

Hurricane Diane, storm of August 17-20, 1955, was one of the most intense storms that has occurred in the region, and it occurred only 1 week after Hurricane Connie which deposited 3 to 6 inches of rain. Thus, when Hurricane Diane struck wetlands were already saturated and streamflows were above normal.

Field investigations made by the Soil Conservation Service indicate that average annual inland flood damage in the region, excluding the main stem Merrimack River, exceeds \$4,900,000 and that a 100-year frequency flood would cause damage in excess of \$80 million. Average annual damages and damages expected from a 100-year flood in each of the region's subwatersheds are summarized in Table 5.11 and depicted geographically on Figure 5.8.

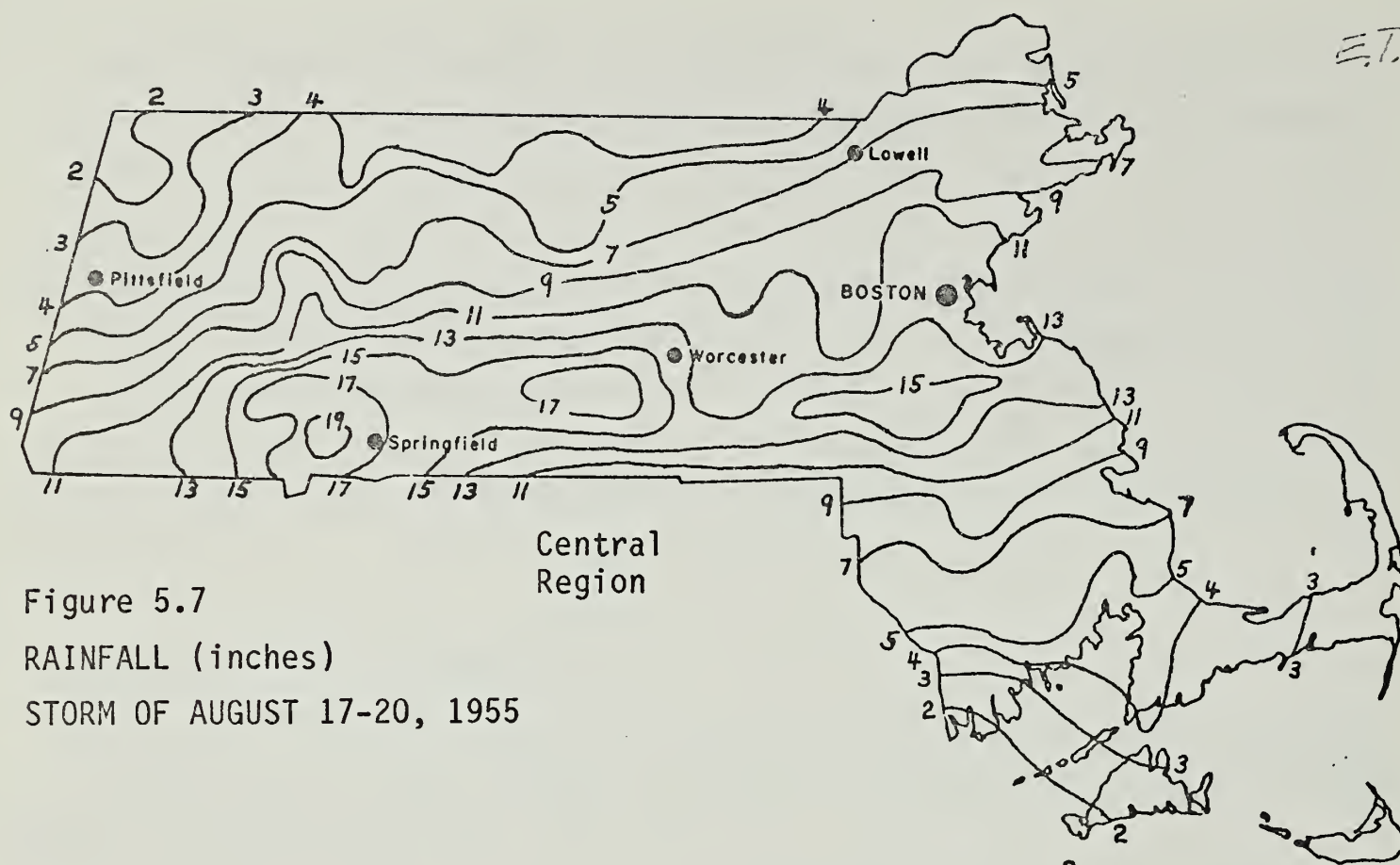


Figure 5.7
 RAINFALL (inches)
 STORM OF AUGUST 17-20, 1955

Historically, many industries were located on flood plains because water was necessary for plant operations. The alternative of developing above the flood plains was more costly since it meant substituting more expensive methods of generating power, discharging waste products and cooling. Roads were developed on flood plains because of lower installation costs--it was less expensive to build on the flat valley lands than to route highways over upland terrain. Residential building upon flood plains also resulted from the lower comparative costs. In addition much residential development was stimulated by the existing industrial flood plain development, i.e., housing for factory workers was often located in close proximity to their employment.

In flood plain development, one significant cost determinant was often excluded from the decision-making process--this being the cost of flood damage. In some instances, the flood hazard was not recognized. In others, the hazard was recognized but the severity was misjudged. In still other cases, federal disaster assistance after the flood encouraged rehabilitation of flood damaged property in the same location.

TABLE 5.11

PRESENT FLOOD DAMAGES 1/

Subwatershed	100-Year Flood Damage	Average Annual Damage
-Merrimack River Watershed- 2/		
ME-1 (Rowley River)		3/
ME-12 (Cow Pond Brook)		3/
ME-13 (Merrimack River)		3/
ME-14 (Stony Brook)		3/
ME-15 (Merrimack River)	\$1,144,300	\$68,700
ME-18 (River Meadow Brook)		3/
ME-19 (Shawsheen River)	1,242,000	74,500
ME-20 (Merrimack River)		3/
ME-21 (Merrimack River)		3/
-Concord River Watershed-		
CO-17 (Concord River)	805,000	48,300
-Assabet River Watershed-		
AS-17 (Assabet River)	112,700	6,800
-Blackstone River Watershed-		
BL-61 (Ramshorn Brook)	285,200	17,100
BL-62 (Blackstone River)		3/
BL-63 (Quinsigamond River)	363,400	21,800
BL-64 (Blackstone River)	958,000	57,500
BL-65 (Mumford River)	2,066,000	124,000
BL-66 (West River)		3/
BL-67 (Mill River)		3/
BL-68 (Abbott Run)		3/
-Thames River Watershed-		
TH-1 (Furnace Brook)		3/
TH-1A (Quinnebaug River)	844,100	50,600
TH-2 (French River)		3/
-Sudbury River Watershed-		
SU-16 (Baiting Brook)	714,500	146,900
SU-17 (Sudbury River)	9,058,300	543,500
-Nashua River Watershed-		
NA-1 (Souhegan River)		3/
NA-2, 3, & 4 (North Nashua River)	62,183,000	3,685,000
NA-5 (Quinapoxet River)		3/
NA-6 (Stillwater River)		3/
NA-7 (Nashua River)	201,300	12,100
NA-8 (Catacoonamug Brook)	115,000	6,900
NA-9 (Mulpus Brook)		3/
NA-10 (Squannacook River)	227,700	13,700
NA-11 (Nashua River)	281,700	16,900

1/ Price Base 1976.

2/ Does not include main stem damage.

3/ Average Annual Damage less than \$5,000.

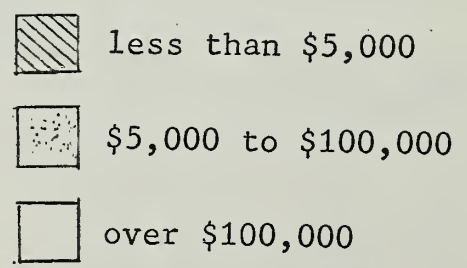
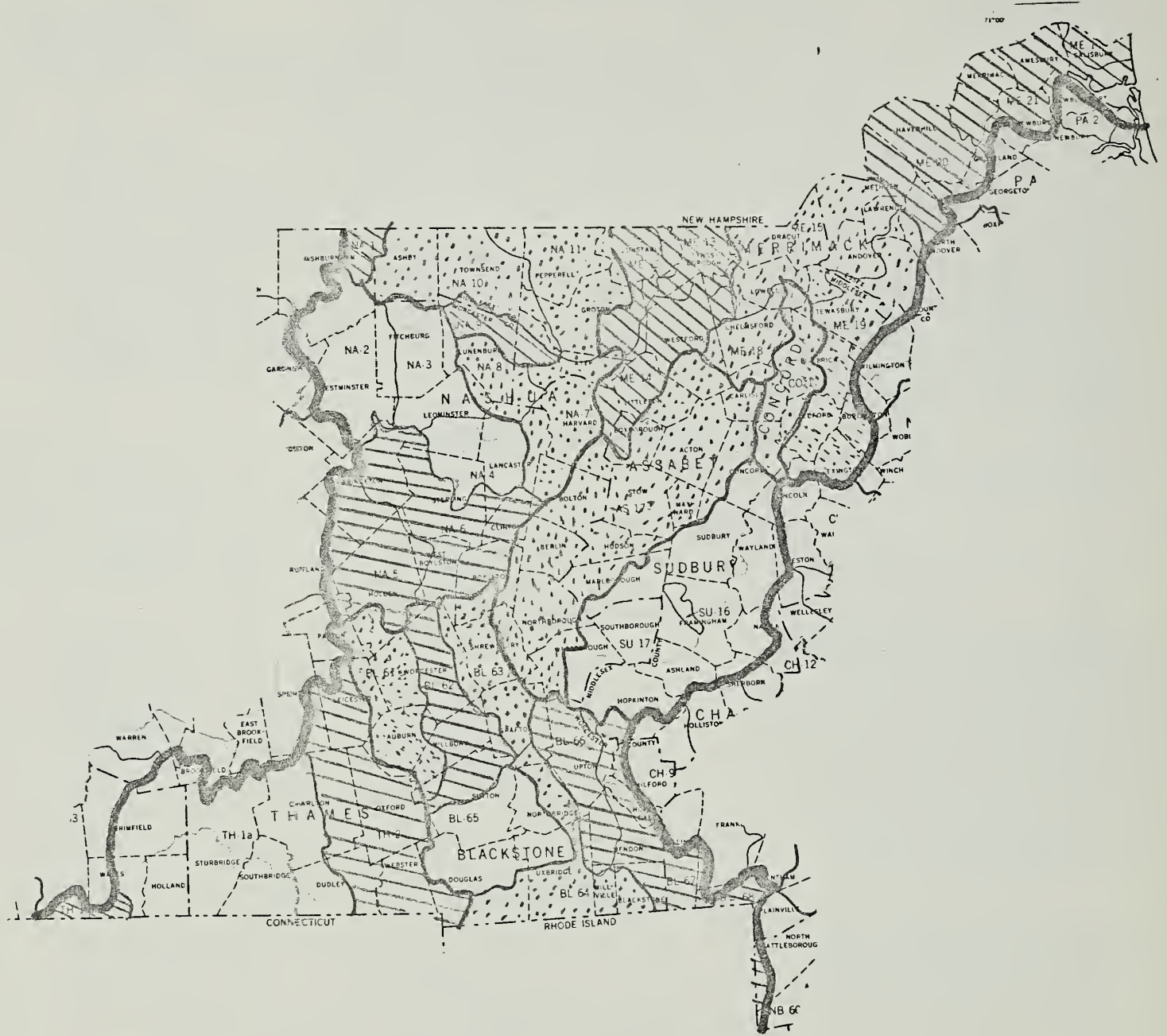


Figure 5.8
Average Annual Flood Damage

Floods cause damage to many properties which have been developed in wetlands or flood prone areas. Many of the property owners do not consider themselves to be in a flood prone area. The 1968 Post Flood Report for the Flood of March 18-25, 1968 in New England, summed the problem as follows:

Many of the developments are some distance from major streams and the threat of flooding was not apparent. Moreover, the first half of the 1960 decade was a time of drought in the north-east and this tended to mask the problem as ground water levels were at record lows during the period. With the return to normal levels in 1967, the area needed only a major storm with rapid runoff to be in real trouble.

The filling of wetlands and encroachment on the flood plains for development not only endangered the developed area itself, but compounded problems downstream. As a wetland is filled, its ability to reduce flood peaks by storing water for later release is diminished. Filling or blocking the flood plains also increased peak flows downstream, but even more important, it causes greater depths of flow and higher velocities for any given flood. In addition, the conversion of marshland and vegetation to buildings and paved parking lots results in an increased volume of runoff for an equal amount of rainfall.

5.4 EROSION AND SEDIMENT

General -- Soil erosion results from the action of moving water, wind, gravity, frost or a combination of these forces on the land. The main concerns in this region are water-activated erosion and its by-product--sedimentation. In addition, natural or geologic erosion should be differentiated from accelerated erosion.

"Natural or geologic erosion is a continuing process and will go on into the future regardless of anything man can do. Quickening of the pace of erosion, owing to changes wrought by man, has produced definitely abnormal conditions. Accelerated erosion, and abnormal and undesirable process, was started by man's activities and is subject to his control."

Sheet, rill, gully, stream and roadbank erosion occur in the region; but, in general, the erosion rate is low in comparison to the southern or western portions of the country.

Erosion is not only a problem in itself, but also serves as a source for sediment. Once erosion has taken place, the eroded material will usually create a second problem when deposited downstream in stream channels, reservoirs, lakes, wetlands and rivers. Along with the individual soil particles which constitute sediment, any fertilizer, pesticide, animal waste or other organic matter attached or adjacent to the soil particles, is also carried off. Some of this also reaches streams and results in a lowering of water quality.

Erosion and sediment problems have historically been corrected with land treatment measures which are the application of a combination of practices that will meet specific objectives. These objectives include controlling soil erosion, decreasing runoff of rainfall, improving soil and plant productivity, improving wildlife habitat, and improving environmental quality. The practices are classified as managerial, vegetative and cultural, or mechanical.

Mechanical practices include diversions, terraces, waterways, outlets, and small grade stabilization structures. These practices are designed to reduce erosion by reducing the length of slope and by providing proper courses for transporting the water at nonerosive velocities. When used with vegetative practices, mechanical practices can be extremely effective in reducing erosion.

Examples of vegetative and cultural practices are: conservation cropping systems, minimum tillage, cover cropping, contour strip cropping and planting of grasses, legumes, proper grazing use, and shrubs and trees on critical areas. These practices protect the soil from the impact of raindrops, reduce runoff and reduce the contact between soil particles and flowing water.

Timber stand improvement, timely field operations, recreation and wildlife area management, and maintenance operations are all examples of managerial practices. These practices minimize the overuse of the land while at the same time improve the condition of the cover.

As mentioned, land treatment is planned for other objectives besides erosion control, but adequate protection of the soil is of primary importance. Land treatment has been found to be as effective in urban applications as it is in the rural sector.

In addition to land treatment, land use planning and structural measures are also applied to minimize erosion. Land use planning can be developed to guide the use, growth and development of land in the cities and towns. Land subject to excessive erosion can be converted to other land uses which have a lower erosion rate. Areas, such as flood plains and steep slopes, can be managed to reduce erosion and sediment damage.

Structural measures can be designed and used to protect the land from erosion and sediment. Some of the appropriate measures are debris basins, rip-rapping, channel improvements, and large grade stabilization structures. Erosion and sedimentation can be reduced by decreasing high stream flows with flood control measures. Impoundments and natural storage basins will also collect the sediment in the stream and reduce sediment deposits downstream. The water quality in the stream should also be improved by reducing sediment loads.

Erosion -- To assess the extent of the erosion and sediment problems in the Central Region, the area was divided into three types based on its general susceptibility to erosion. These "Erosion Land Types" were: (1) upland, (2) terrace and, (3) flood plain. Location and extent of the types are shown on Figure 5.9.

Potential erosion problem areas were listed to insure that all categories of erosion were considered. Based on the judgement of Soil Conservation

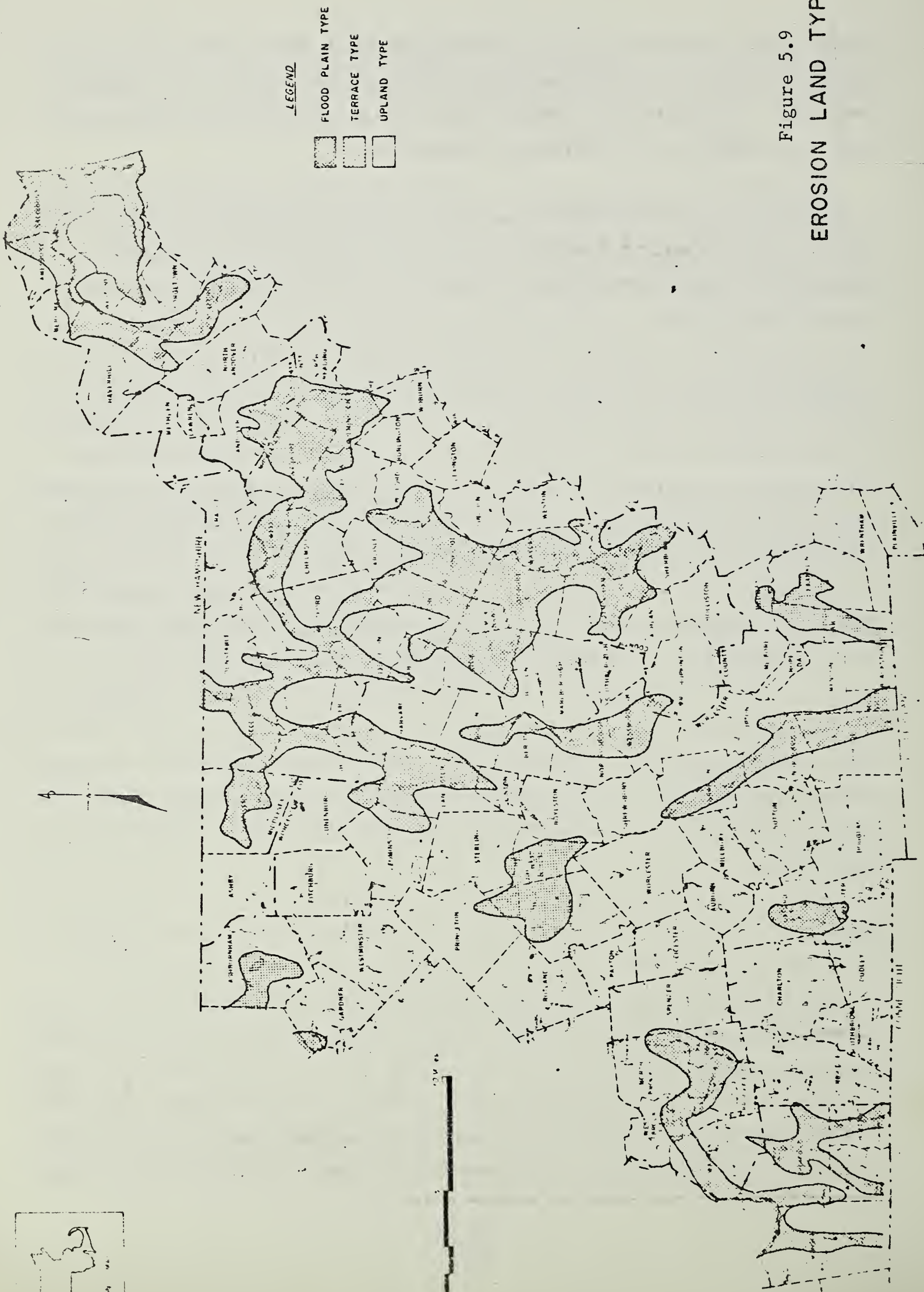


Figure 5.9
EROSION LAND TYPE MAP

Service field technicians, the following types of areas were thought to represent the major erosion potential: farmland in cultivation, logging roads and skid trails, roadbanks, unpaved roads, gravel pits, construction areas, streambanks, and utility rights-of-way.

These potential erosion problems were studied using a sampling basis to determine the extent of the erosion. Samples were made in each of the three "Erosion Land Type" areas. Soil Conservation Service technicians visited known problem areas to quantify the erosion. Gravel pits and construction areas were also selected based on known problems or areas which appeared to have potential problems. Forestland erosion rates were estimated by Forest Service personnel. Erosion from roadbanks, unpaved roads, streambanks and utility rights-of-way was estimated by inventorying the problems noted along a specified length of sample reach.

These erosion samples and case studies formed the basis for calculating erosion rates for the various problem types in each "Erosion Land Type." The MacConnell's Massachusetts Map Down series was used to determine the number of acres in various land uses in each "Erosion Land Type." Total erosion estimates for the Central Region are presented in Table 5.12.

Gravel pits and earth removal operations with their disruption of vegetation and steep slopes were thought to be potential erosion and sediment problems. Examination showed that although erosion of side slopes was indeed a severe problem in terms of the volume of soil being moved, in most instances, little or no material left the actual gravel pit thus eliminating the offsite sediment problem. It seems that what appeared to be a major source of sediment was rarely a problem beyond the limits of the removal operation. Field examination showed that erosion of roadbanks was also a minor problem.

Regulations are the probable reason for gravel pits being a minor element of the total erosion picture. Over 85 percent of the communities in the region have bylaws which regulate gravel pits and earth removal activities. These communities are shown on Figure 5.10.

TABLE 5.12

CENTRAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acres)	Annual Erosion (tons)
<u>Central Region</u>			
1. Tilled Cropland	12,504	(6.4)	79,085
2. Other Agricultural Land	90,574	(0.26)	23,758
2.1 Orchards, bushfruit and nurseries	9,078	0.25	2,252
2.2 Pasture, hayland and unused tilled cropland	81,496	(0.26)	21,506
3. Other lands (abandoned fields and orchards, etc.)	44,074	0.25	11,105
4. Forest (does not include wooded swamps)	601,724	0.2	108,817
5. Wetlands, wooded swamps (non- sediment producing)	84,548	0	0
6. Urban	213,212	0.3	64,136
7. Construction Sites (annual)	6,392	39.	251,763
LAND EROSION TOTAL	1,053,028	(0.5)	538,664
8. Streambanks susceptible to erosion	(miles)	(tons/mile)	
Major Streams	139	210	29,25
Tributaries	168	453	76.048
TOTAL EROSION			643,964

Essex County

1. Tilled Cropland	1,470	(6.2)	9,102
2. Other Agricultural Land	9,510	(0.2)	2,008
2.1 Orchards, bushfruit and nurseries	744	0.2	149
2.2 Pasture, hayland and unused tilled cropland	8,766	.2	1,859
3. Other lands (abandoned fields and orchards, etc.)	4,814	0.2	963
4. Forest (does not include wooded swamps)	37,22	0.15	5,584
5. Wetlands, wooded swamps (non- sediment producing)	8,324	0	0
6. Urban	30,598	0.3	9,179
7. Construction Sites (annual)	750	39.0	29,250
LAND EROSION TOTAL	92,693	(0.6)	56,086

TABLE 5.12

CENTRAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acres)	Annual Erosion (tons)
<u>Hampden County</u>			
1. Tilled Cropland	441	(5.9)	2,592
2. Other Agricultural Land	2,281	(0.2)	456
2.1 Orchards, bushfruit and nurseries	126	0.2	25
2.2 Pasture, hayland and unused tilled cropland	2,155	0.2	431
3. Other lands (abandoned fields and orchards, etc.)	1,650	0.2	330
4. Forest (does not include wooded swamps)	31,625	0.2	6,325
5. Wetlands, wooded swamps (non- sediment producing)	1,762	0	0
6. Urban	1,731	0.4	692
7. Construction Sites (annual)	75	72.	5,400
LAND EROSION TOTAL	39,565	(0.)	15,795

<u>Middlesex County</u>			
1. Tilled Cropland	4,878	(6.1)	29,546
2. Other Agricultural Land	29,109	(0.2)	6,264
2.1 Orchards, bushfruit and nurseries	3,745	0.2	739
2.2 Pasture, hayland and unused tilled cropland	25,364	0.2	5,525
3. Other lands (abandoned fields and orchards, etc.)	14,718	0.2	2,944
4. Forest (does not include wooded swamps)	193,328	0.15	28,999
5. Wetlands, wooded swamps (non- sediment producing)	35,811	0	0
6. Urban	86,679	0.3	26,004
7. Construction Sites (annual)	2,808	39.0	109,512
LAND EROSION TOTAL	367,331	(0.5)	203,269

TABLE 5.12

CENTRAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acres)	Annual Erosion (tons)
<u>Worcester County</u>			
1. Tilled Cropland	5,715	(6.6)	37,845
2. Other Agricultural Land	49,674	(0.3)	15,030
2.1 Orchards, bushfruit and nurseries	4,463	0.3	1,339
2.2 Pasture, hayland and unused tilled cropland	45,211	0.3	13,691
3. Other lands (abandoned fields and orchards, etc.)	22,892	0.3	6,868
4. Forest (does not include wooded swamps)	339,544	0.2	67,909
5. Wetlands, wooded swamps (non- sediment producing)	38,651	0	0
6. Urban	94,204	0.3	28,261
7. Construction Sites (annual)	2,759	39.	107,601
LAND EROSION TOTAL	553,439	(0.5)	263,514

The bylaws and regulations are designed to limit the offsite effects of earth removal activities and seem quite successful in accomplishing their intended purpose.

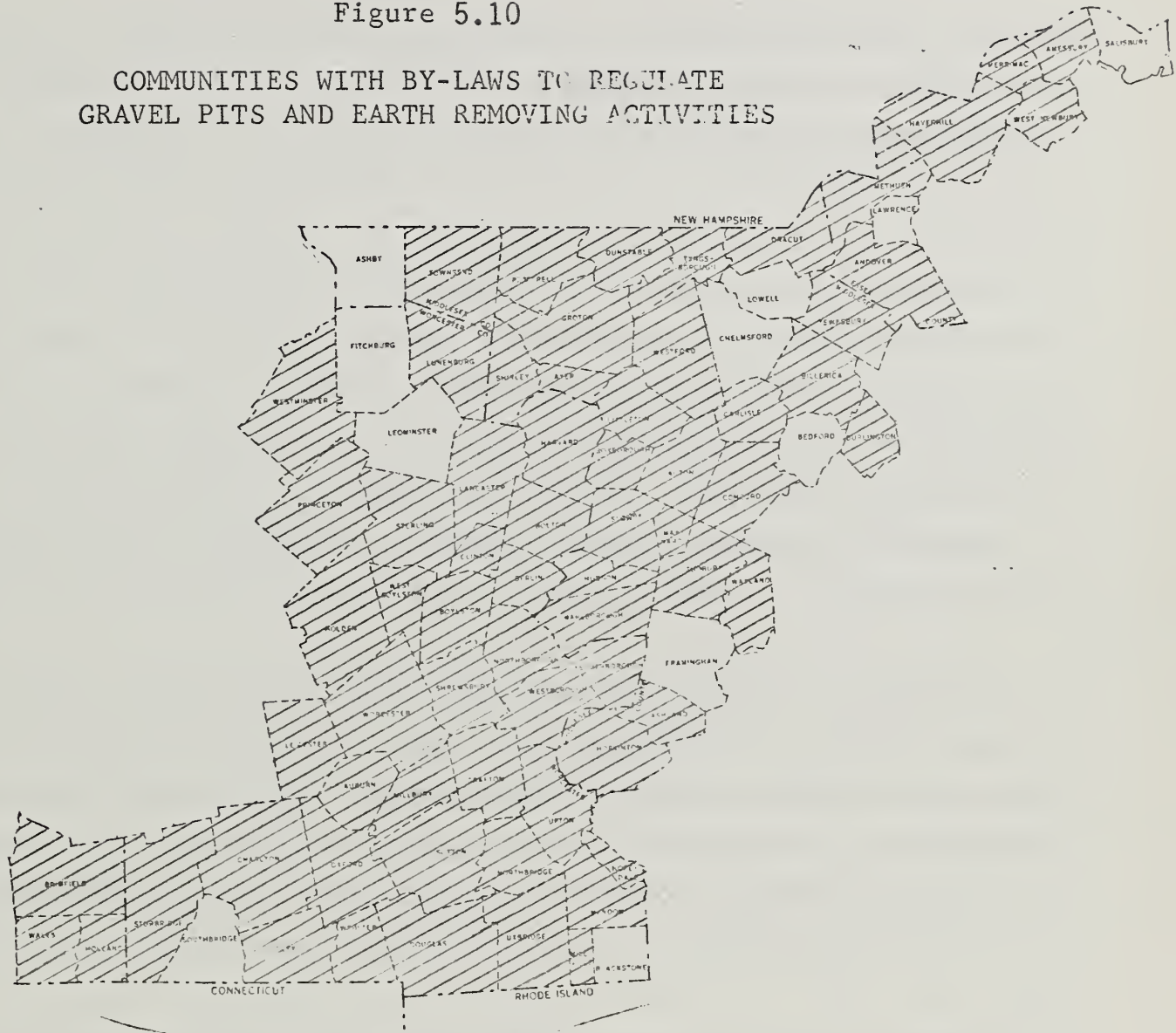
Erosion along roadways was found to be a minor problem in the region; however, isolated severe cases of roadbank erosion exist. But when they are found, they represent a small percentage of the total roadbank mileage.

Total gross erosion from developed urban areas is relatively low (64,000 tons per year). This is because in stabilized urban areas almost all of the land surface is covered with roofs, asphalt or other paving, or permanent vegetation. The annual erosion rate of urban land is estimated at 0.3 tons per acre.

The areas with the highest erosion rates were found to be areas which were under construction. The average erosion rate for construction sites was estimated to be 39 tons per acre. This figure varies enormously depending

Figure 5.10

COMMUNITIES WITH BY-LAWS TO REGULATE
GRAVEL PITS AND EARTH REMOVING ACTIVITIES



on such factors as site topography, slope, construction practices, and time of year. Construction areas have the highest rates of erosion since, by their very nature, they involve the removal of protective vegetation and exposure of bare soil to the effects of wind and, more importantly, water.

Erosion control practices during construction can do much to reduce the rate and extent of erosion. The Soil Conservation Service has prepared a publication entitled "Guidelines for Soil and Water Conservation in Urbanizing Areas of Massachusetts" which details some of these erosion control practices that can be utilized on construction. Erosion control measures during construction add minimally to the total construction cost, however, many contractors and owners are reluctant to spend money for "nonconstruction" type measures. Many communities have some minor control on erosion during construction through zoning, building or other bylaws. This method is not very effective and fails to cover many aspects of the problem. Only one or so communities actually have adequate and effective sediment and erosion control bylaws.

The regional average erosion rate of tilled cropland is 6.4 tons per acre per year. Soil scientists estimate that to maintain productivity overtime, annual soil losses on most of Massachusetts' agricultural soils must be limited to no more than 3 tons per acre. So at present the average erosion rate of tilled cropland is over two times this maximum annual rate. Erosion on about 80 percent of this tilled land is less than the tolerable annual soil loss. The high average is from excessive losses on less than 20 percent of the tilled land and is the result of poor management. On certain individual farms sampled annual erosion rates of over 80 tons per acre were computed for field corn. Worcester and Middlesex Counties account for approximately 85 percent of the tilled cropland erosion in the region.

Establishment and maintenance of good conservation practices by the majority of the region's farm operators has done much to reduce total erosion from farmland. However, more needs to be done by the minority of farmers who have erosion problems on their land.

Sampling and surveys have shown that erosion from wetlands, hayland, pasture, forest, orchards, abandoned fields, and established urban areas is not a serious matter.

Streambank erosion is a problem in the region. Although the total volume of streambank erosion is only 16 percent of the total erosion, a far greater proportion, over 50 percent, of the streambank erosion ends up as sediment in streams, lakes, ponds, or rivers.

Sediment -- If the entire volume of erosion in the region were to result in sediment which was delivered to streams and rivers, the results would be catastrophic. Fortunately, a large percentage of the erosion products from land areas are deposited on land before reaching a watercourse. Stone walls, fences, strips of vegetation, forestland, and even flat slopes cause the erosion products to be deposited. Delivery rates of sediment to streams may be 10 percent or less of the original eroded volume.

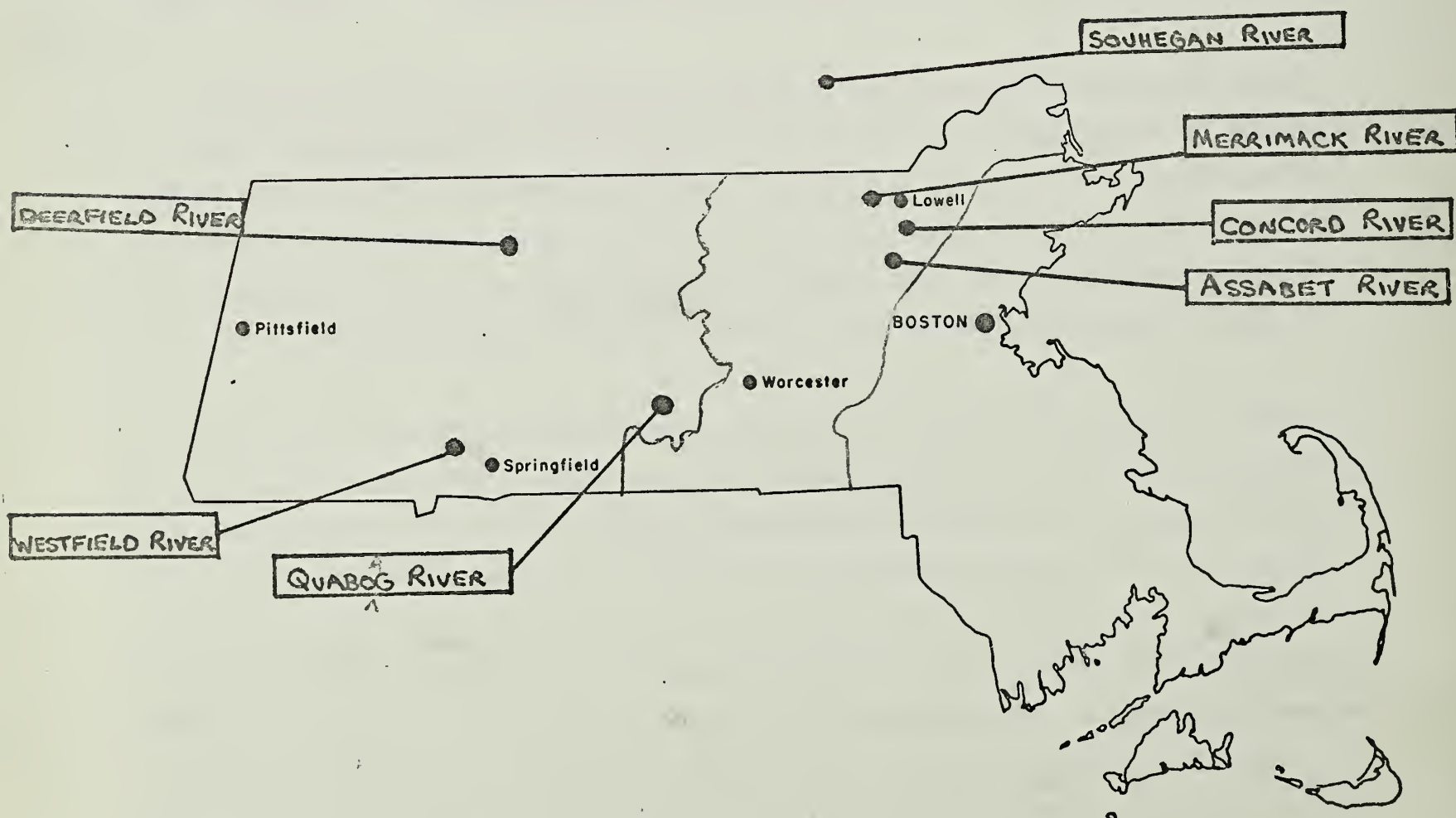
On the other hand, erosion from streambanks results in a very high percentage of eroded material becoming sediment. Cobbles and boulders usually remain fairly close to their original location, sand may settle out in the flat stretches of streams and in pools, but the fine sand and silt fraction remains as suspended sediment to dirty the water and reduce its value as fish habitat and as habitat for insects in the fish food-chain.

Suspended sediment measurement stations have been established throughout Massachusetts by the U.S. Geological Survey. These stations are located on major streams and monitor suspended sediment at the USGS stream gage locations. Station locations and pertinent data are shown on the map accompanying Table 5.13. Flow-duration data combined with suspended sediment readings were used to prepare average annual sediment data for each station.

The results of the average annual sediment calculations are presented in Table 5.13. Although the data has significant scatter when plotted, it does present a rough idea of values to be expected for the suspended sediment.

TABLE 5.13 SEDIMENT ESTIMATES AT SELECTED STREAM GAGES

Stream Gage	Drainage Area (sq. miles)	Suspended Sediment (tons/sq. mile)	Total Sediment (tons/sq. mile)
Merrimack River above Lowell, Mass.	4635	53.1	55.8
Concord River at Lowell, Mass.	405	13.0	15.7
Assabet River at Maynard, Mass.	116	7.4	10.1
Souhegan River New Hampshire	171	2.1	23.7
Westfield River near Westfield, Mass.	497	81.9	84.6
Deerfield River near W. Deerfield, Mass.	558	49.2	51.9
Quaboag River at W. Brimfield, Mass.	151	12.9	15.6



The range of values is between 0.015 tons/acre and 0.155 tons/acre. There appears to be little correlation between the size of drainage area and the amount of suspended sediment per unit area. Factors such as upstream wetlands and dams which act as sediment traps, and effluents from sewage treatment plants are responsible for much of the scatter in the data.

Based on the analysis of suspended sediment data and estimates of quantities of the larger sized "bedload" sediment, it is estimated that total annual sediment in the rivers and streams of the region is approximately 64,000 tons or about 10 percent of the total erosion in the region.

5.5 WETLANDS

Wetlands are those areas where the water table is at or near the ground surface for much of the year and are subject to occasional flooding. In the Central region, wetlands include swamps, marshes, bogs, beaver ponds, salt marshes, salt meadows, seasonally flooded flats, and wet meadows. The soils of the wetlands are usually poorly or very poorly drained, except for beaver ponds and seasonally flooded flats. The latter are usually alluvial or flood plain soils which may have better drainage.

There are 2,527 acres of coastal wetlands, salt marshes and salt meadows, as mapped by MacConnell et al., in the region, all in the town of Salisbury.

Approximately 2,400 acres of these tidal wetlands in Salisbury are protected from development by restriction under the Massachusetts Coastal Wetlands Act, G.L. Ch. 130, Sec. 105.

See Table 5.14 Inland Wetlands, Regional Summary, and Table 5.15 Inland Wetlands Areas, which lists inland wetland acreage of the region's municipalities. The wetland figures do not include flood plain lands that are dry most of the year although these usually dry portions of flood plains

TABLE 5.14

INLAND WETLANDS REGIONAL SUMMARY

	Open Type 1/ (acres) 2/	Wooded Swamps 3/ (acres)	Total (acres)	Fresh Open Water 4/ (acres)	Grand Total (acres)
Merrimack	6,377	8,854	15,231	8,739	23,970
SuAsCo	9,134	18,082	27,216	7,478	34,694
Nashua	4,382	14,640	19,022	11,804	30,826
Blackstone	3,583	7,175	10,758	5,002	15,760
Thames	2,218	7,574	9,792	5,933	15,725
Totals	25,694	56,325	82,019	38,956	120,975

1/ Data obtained from Massachusetts Map Down Project at University of Massachusetts, directed by Prof. William P. MacConnell.

2/ These open type wetlands, as mapped by MacConnell et al., are based on the wetlands classification presented in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service. The Massachusetts Map Down wetland types included in the open type wetlands column above and the equivalent wetland type of the U.S. Fish and Wildlife Service, Circular 39, are as follows: Seasonally flooded basins or flats--Type 1; Bog--Type 8; Shrub Swamp--Type 6; Meadow--Type 2; Shallow Marsh--Type 3; Deep Marsh--Type 4; Beaver Pond--Type 3 or 4.

3/ Measured by the Soil Conservation Service. This is equivalent of Type 7, Circular 39.

4/ This is equivalent of Type 5, Circular 39.

Table 5.15

WETLAND AREAS

Municipality	Open ^{1/2/} Wetlands (acres)	Wooded ^{3/} Swamps (acres)	Total Inland Wetlands (acres)	Total % of Fresh ^{4/} Municipal Area	Open Water (acres)	Grand Total (acres)	Total % of Municipality Area
<u>Merrimack Study Area</u>							
Amesbury	363	311	679	7.7	525	1,204	13.6
Andover	575	845	1,420	6.9	586	2,006	9.7
Burlington	126	362	488	6.5	0	488	6.5
Chelmsford	632	427	1,059	7.0	238	1,297	8.5
Dracut	141	517	658	4.9	251	909	6.7
Dunstable	352	945	1,297	12.0	82	1,379	12.7
Haverhill	469	766	1,235	5.4	764	1,999	8.7
Littleton	378	592	970	8.6	535	1,505	13.3
Lowell	83	18	101	1.1	0	101	1.1
Lawrence	22	31	53	1.1	18	71	1.5
Merrimack	103	238	341	6.0	13	354	6.2
Methuen	550	437	987	6.7	96	1,083	7.4
Salisbury	242	69	311	2.8	0	311	2.8
Tewksbury	482	1,236	1,718	12.5	145	1,863	13.6
Tyngsborough	361	273	634	5.7	328	962	8.6
Westford	948	1,561	2,509	12.6	499	3,008	15.1
W. Newbury	545	226	771	8.1	205	976	10.3
Subtotal	6,377	8,854	15,231	7.2	4,285	19,516	9.3
<u>Nashua Study Area</u>							
Ashby	80	153	233	1.6	294	527	3.6
Ayer	260	158	418	6.9	280	698	11.6
Boylston	85	1,025	1,110	8.9	2,293	3,403	27.4
Clinton	22	33	55	1.2	1,023	1,078	23.3
Fitchburg	25	56	81	0.4	201	282	1.6
Groton	604	1,647	2,251	10.4	447	2,698	12.4
Harvard	612	778	1,390	8.1	387	1,779	10.3
Holden	263	1,038	1,301	5.6	775	2,076	9.0
Lancaster	301	1,350	1,651	9.2	733	1,884	10.4
Leominster	145	519	664	3.5	540	1,204	6.3
Lunenburg	435	1,245	1,680	9.4	989	2,669	15.0
Pepperell	204	843	1,047	7.1	28	1,075	7.3
Princeton	189	1,726	1,915	8.4	115	2,030	8.9
Shirley	199	809	1,008	10.5	14	1,022	10.6
Sterling	282	926	1,208	6.0	842	2,050	10.2
Townsend	204	1,094	1,298	6.2	87	1,385	6.6
W. Boylston	61	288	349	3.9	714	1,063	11.9
Westminster	411	952	1,363	5.7	1,315	2,678	11.2
Subtotal	4,382	14,640	19,022	6.5	10,579	29,601	10.1

Table 5.15

WETLAND AREAS

Municipality	Open ^{1/2/} Wetlands (acres)	Wooded ^{3/} Swamps (acres)	Total Inland Wetlands (acres)	Total % of Municipal Area	Fresh ^{4/} Open Water (acres)	Grand Total (acres)	Total % of Municipality Area
<u>Blackstone Study Area</u>							
Auburn	101	259	360	3.4	640	1,000	9.6
Blackstone	138	294	432	6.0	194	626	8.7
Douglas	324	1,684	2,008	8.2	740	2,748	11.2
Grafton	572	633	1,205	8.2	193	1,398	9.5
Hopedale	172	131	303	9.0	40	343	10.2
Mendon	252	873	1,125	9.8	115	1,240	10.8
Millbury	286	343	629	6.1	233	862	8.4
Millville	66	154	220	6.9	3	223	7.0
Northbridge	347	358	705	6.0	415	1,120	9.6
Sutton	327	885	1,212	5.5	862	2,074	9.4
Upton	335	566	901	6.5	116	1,017	7.4
Uxbridge	564	823	1,387	7.2	372	1,759	9.2
Worcester	99	172	271	1.1	514	785	3.2
Subtotal	3,583	7,175	10,758	6.1	4,437	15,195	8.6
<u>Thames Study Area</u>							
Brimfield	314	742	1,056	4.6	337	1,393	6.1
Charlton	145	1,798	1,943	7.0	890	2,833	10.2
Dudley	285	507	792	5.7	555	1,347	9.6
Holland	85	264	349	4.3	430	779	9.7
Leicester	72	1,034	1,106	7.0	931	2,037	13.0
Oxford	394	807	1,201	6.9	328	1,529	8.7
Southbridge	153	505	658	5.0	218	876	6.6
Sturbridge	388	1,397	1,785	7.1	818	2,603	10.4
Wales	84	273	357	3.7	136	493	5.0
Webster	298	247	545	5.9	1,227	1,772	19.1
Subtotal	2,218	7,574	9,792	6.0	5,870	15,662	9.6

Table 5.15

WETLAND AREAS

Municipality	Open ^{1/2/} Wetlands (acres)	Wooded ^{3/} Swamps (acres)	Total Inland Wetlands (acres)	Total % of Municipal Area	Fresh ^{4/} Water (acres)	Grand Total (acres)	Total % of Municipality Area
<u>SuAsCo (Sudbury, Assabet and Concord)</u>							
<u>Study Area</u>							
Acton	483	676	1,159	9.0	200	1,359	10.5
Ashland	68	583	651	7.9	362	1,013	12.3
Bedford	638	870	1,508	16.9	9	1,517	17.0
Berlin	232	263	495	5.9	98	593	7.0
Billerica	537	741	1,278	7.6	113	1,391	8.2
Bolton	209	709	918	7.2	47	965	7.6
Boxborough	206	1,029	1,235	18.5	18	1,253	18.8
Carlisle	278	1,103	1,381	14.0	67	1,448	14.6
Concord	1,070	668	1,738	10.5	539	2,277	13.8
Framingham	212	458	670	4.0	869	1,539	9.1
Hopkinton	298	1,803	2,101	11.7	1,002	3,103	17.3
Hudson	344	223	567	7.4	85	652	8.5
Marlborough	193	661	854	5.9	730	1,584	11.0
Maynard	112	404	516	15.2	53	569	16.8
Northborough	336	1,223	1,559	13.2	100	1,659	14.0
Shrewsbury	197	572	769	5.6	542	1,311	9.5
Southborough	298	468	766	7.8	872	1,638	16.6
Stow	373	1,212	1,585	13.6	221	1,806	15.5
Sudbury	1,174	1,834	3,008	19.2	166	3,174	20.2
Wayland	1,154	715	1,869	18.4	186	2,055	20.2
Westborough	722	1,867	2,589	19.0	274	2,863	21.1
Subtotal	9,134	18,082	27,216	11.0	6,553	33,769	13.6
Region Total	25,694	56,325	82,019	7.5	31,724	113,743	10.4

^{1/} Data obtained from Massachusetts Map Down Project at University of Massachusetts, directed by Professor William P. MacConnell.

^{2/} These open type wetlands, as mapped by MacConnell et al, are based on the wetlands classification presented in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service. The Massachusetts Map Down wetland types included in the open type wetlands column above and the equivalent wetland type of the U.S. Fish and Wildlife Service, Circular 39, are as follows: Seasonally flooded basins or flats--Type 1; Bog--Type 8; Shrub Swamp--Type 6; Meadow--Type 2; Shallow Marsh--Type 3; Deep Marsh--Type 4; Beaver Pond--Type 3 or 4.

^{3/} Measured by the Soil Conservation Service. This is equivalent of Type 7, Circular 39.

^{4/} This is equivalent of Type 5, Circular 39.

are in the same jurisdictional category as wetlands in Massachusetts wetland legislation. The approximately 82,000 acres of inland wetlands in the region represents 7.5 percent of the total area. The range is from 0.4 percent in Fitchburg to 19.2 percent in Sudbury.

Wetlands are important for flood control, wildlife habitats, and to a lesser degree for water quality and ground water aquifer protection. Wetlands are extremely poor sites for industrial, commercial, and residential development because of high water tables, flooding hazards, and the possibility of having non-stable organic materials in the soils underlying building foundations. High water tables eliminate the use of septic tank and leach field systems for onsite sewage disposal, create serious site drainage problems, and make the use of building basements impractical and often impossible. The presence of organic material--muck or peat--in a foundation often results in differential settlement and cracking of the structure or fill. Removal of mucks and peats, particularly deep deposits, is usually a necessity for all but the lightest of fills or structures.

Wetlands act as natural floodwater retarding basins which store floodwaters and, thus, lower downstream peak flood flows. Loss of these storage areas can result in higher flood peaks and more extensive flooding downstream.

Many wildlife species depend directly on wetlands for food and habitat. As a result, wetlands provide many opportunities for recreational activities such as hunting and wildlife observation.

Stream water quality can be either adversely or advantageously modified by wetlands. An example of adverse modifications can occur when wetland aquatic plants including algae, die and decay. During this decomposition, dissolved oxygen can be lowered to inadequate levels to sustain fish and other aquatic animal life. Often, this situation is triggered by nutrient loadings from upstream domestic or industrial waste water effluents. Wetlands can also enhance water quality by acting as sediment traps and nutrient filters. The quality of the incoming water and the condition of the

wetland must be known to determine how a particular wetland will effect water quality.

In the region, the major ground water aquifers are usually in the bottom lands or flood plains along or near the major streams. These aquifers are often surfaced by wetlands. A measure of protection to underlying aquifers can be provided by maintaining these wetlands.

Most inland wetlands, during normal or dry periods, act as areas of ground water discharge. During times of flood, however, there is the possibility of recharge into ground water storage areas through their wetlands cover. Also the storing of floodwater in upland wetlands and the releasing of lower flows for a longer period of time from them may allow advantageous recharge conditions to develop downstream.

The Massachusetts Water Resources Study has evaluated 59 of the largest inland wetlands in the Central Region. The wetlands were studied for their value for flood control, timber production, wetland wildlife habitat, recreation, visual quality, and uniqueness. The methodology and criteria employed in the evaluation is discussed in Appendix B. Results of the evaluation are presented in Table 5.16. Figure 5.11 indicates the location of the wetlands which were investigated.

The wetland evaluations are not intended to be used as the sole tool to rank wetlands within the region, nor should a "Low" rated wetland be considered a prime candidate for filling and development. Rather, the ratings can be used to indicate those wetlands which are obviously important to the water resources of the region. Wetlands which are rated "High" for a number of categories should also appear high on a list of wetlands to be acquired by government, or protected by restrictions or conservation easements. Wetlands which are rated "Low" in most categories may not be too important from a water resources standpoint. The wetland evaluation, in effect, is one aid to establishing priorities in wetlands protection. Caution needs to be reemphasized at this point. A low rating may be due

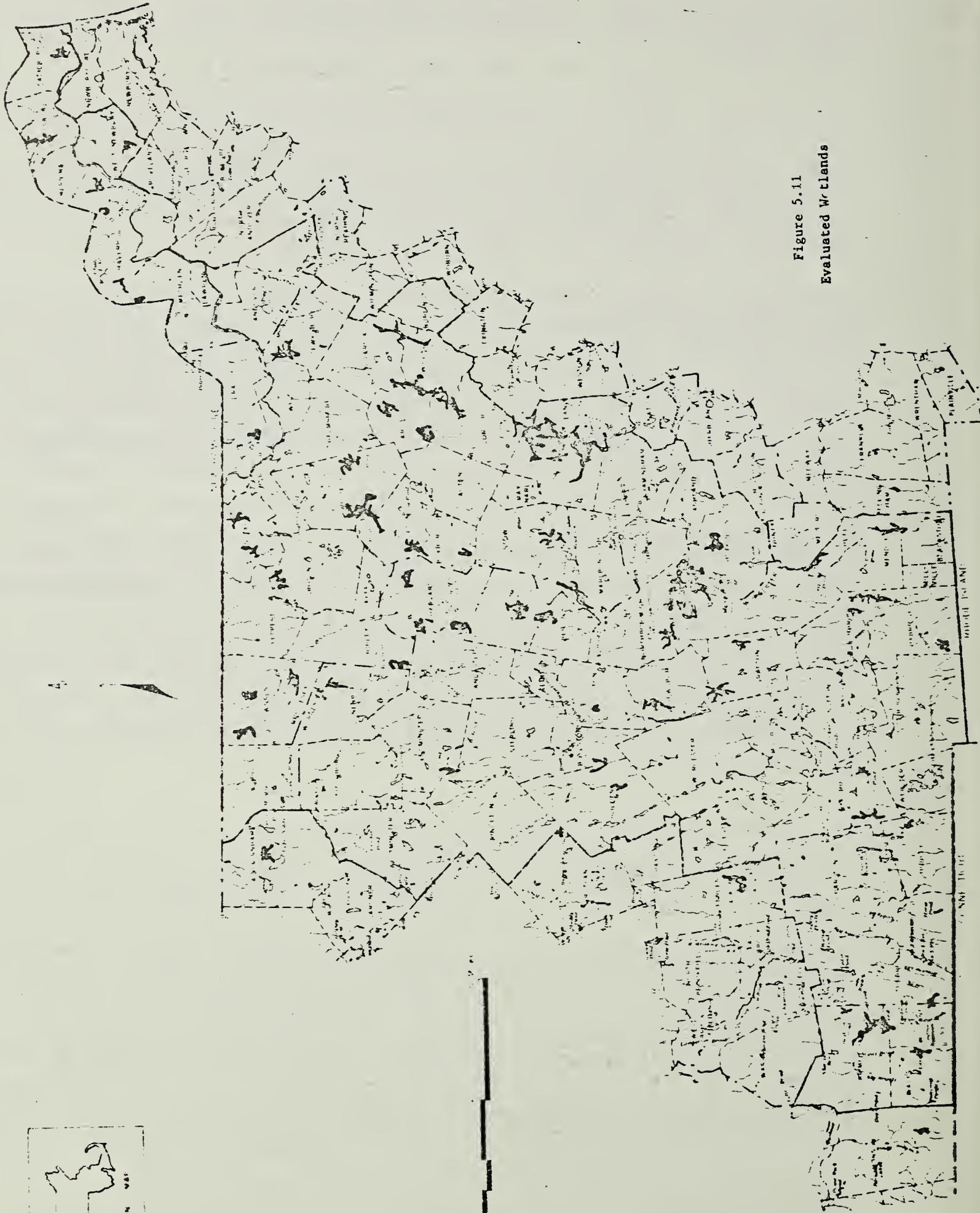


Figure 5.11
Evaluated Wetlands

Table 5.16

Wetland Evaluation Results

Wetland Number	Location Description	Wetland Size (Acres)	Wetland Types (Acres)					Evaluation Rating for:				Wetland Wildlife Habitat	Recreation Uniqueness	Visual Quality
			1	2	3	4	5	Forest Management	Flood Control	Fish Habitat	Wetland Wildlife Habitat			
N-1	Ayers Village Wetland, Haverhill	116					6	High	Mod.	N.R.	Mod.	Low	Low	Mod.
N-2	Crosvevor Corner Wetland, Methuen	138						High	Mod.	N.R.	Mod.	Low	Low	Mod.
N-3	Fast Meadow River Wetland, Haverhill	144					4	High	Low	N.R.	Mod.	Low	Low	Mod.
N-4	Kenoza Lake Wetland, Haverhill	92			39			N.R.	Mod.	N.R.	Low	Low	Low	Mod.
N-5	Pow Wox. River Wetland, Amesbury	413	104					High	High	N.R.	Mod.	Low	Low	High
N-6	Ash Swamp, West Newbury	157	7	5			5	High	Mod.	Low	Mod.	Mod.	Mod.	High
N-7	Town Creek Wetland, Salisbury	110			8		102	N.R.	Low	N.R.	Mod.	Low	High	Mod.
N-8	Spruce Swamp, Dracut	125			3		71	High	High	N.R.	Mod.	Low	Low	Mod.
N-9	Great Swamp, Tewksbury	443	20				15	High	High	N.R.	Mod.	Low	Low	High
N-10	Peaver Brook Wetland, Littleton	129	23	6	17		83	High	High	N.R.	Mod.	Low	Low	Mod.
N-11	Bennetts Brook Wetland, Harvard	142	3		20	3	114	High	High	N.R.	High	Low	Low	Mod.
N-12	Shawsheen River Wetland, Billerica	216			187		6	Mod.	Mod.	Low	Mod.	Low	Low	Mod.
N-13	Hawk Swamp, Dunstable	160				4	156	High	Mod.	N.R.	Mod.	Low	Low	Mod.
N-14	Salmon Brook Wetland, Dunstable	107	10		62	2	9	High	Low	N.R.	Mod.	Low	Low	Mod.
N-15	Beaver Brook Wetland, Westford, Littleton	411	221		20	35	28	Mod.	Mod.	N.R.	High	Mod.	Low	High
N-16	Tadnuck Swamp, Westford, Chelmsford	372		4		8	13	High	Mod.	N.R.	High	Low	Low	High
N-17	Wolf Swamp, Boxborough	167					2	High	Low	N.R.	Mod.	Low	Low	Mod.
S-1	Spencer Brook Wetland, Carlisle, Concord	146	10	8	10		118	High	Mod.	N.R.	Mod.	Low	Low	Mod.
S-2	Concord River Wetland, Concord, Carlisle, Bedford	1373	418		70	180	76	Mod.	Low	Mod.	High	High	High	High
S-3	Tophet Swamp, Carlisle	167					4	High	Mod.	N.R.	Mod.	Low	Low	Low
S-4	Hog Swamp, Berlin, Bolton	277				16	6	High	High	N.R.	High	Low	Low	High
S-5	Assabet River - Fort Meadow Brook Wetland, Hudson, Stow	235			1	19	116	High	Low	N.R.	High	Mod.	Low	High
S-6	Sunk Meadow, Bolton	178		2			170	High	Mod.	N.R.	Mod.	Low	Low	Mod.
S-7	Assabet River Wetland, Marlborough, Berlin, Hudson	149	20		122		7	N.R.	Mod.	N.R.	Mod.	Low	Low	Mod.
S-8	Sudbury River Wetland, Wayland, Sudbury, Framingham	3436	576		125	9	55	High	Mod.	Mod.	High	High	High	High
S-9	Cedar Swamp, Westborough, Hopkinton	1583	36		99	44	17	High	High	Mod.	High	High	High	High
S-10	Assabet River Wetland, Westborough, Northborough	333			13		83	High	Mod.	N.R.	Mod.	Low	High	Mod.
S-11	Indian Brook Wetland, Hopkinton	359			10	10	3	Mod.	Mod.	Mod.	High	Low	High	High
N-1	Nashua River Wetland, Harvard	467		6	76	72	56	High	Low	N.R.	High	High	High	High
N-2	Ash Swamp, Townsend	101	16	26			11	High	Low	N.R.	Mod.	Low	Low	Mod.
N-3	Meadow Road Wetland, Townsend	159		9			150	High	High	N.R.	Mod.	Low	Low	High
N-4	Squamacook River Wetland, Townsend	168			2	14	23	High	Low	Mod.	Mod.	Mod.	Low	High
N-5	Reedy Meadow, Grafton	296		8		4	284	High	Mod.	N.R.	High	Mod.	Low	High
N-6	Lincoln Pond Swamp, Ashburnham	291			14		33	High	Mod.	Mod.	Mod.	Mod.	High	Mod.
N-7	Tophet Swamp, Shirley	142			14		14	High	High	N.R.	Mod.	Low	High	Mod.
N-8	Flurcum Swamp, Lunenburg	188			14	52		High	Mod.	N.R.	Mod.	Mod.	High	Mod.
N-9	Holbrook Swamp, Rutland	95					95	High	Low	N.R.	Low	Low	Low	Mod.
N-10	Buttleft Swamp, Leominster	80					80	Mod.	Mod.	N.R.	Low	Low	Low	Mod.

Table 5.16

Wetland Evaluation Results

Wetland Number	Location Description	Wetland Size (Acres)	Wetland Types (Acres)							Evaluation Rating for:				Visual Quality
			1	2	3	4	5	6	7	Forest Management	Flood Control	Fish Habitat	Wetland Wildlife Habitat	Recreation Uniqueness
N-11	Bolton-Marvard Swamp, Bolton, Harvard	50			2			6	42	High	Low	N.R.	Mod.	Low
N-12	Chaffin Pond Wetland, Holden	150			50	48	32	20		N.R.	High	Mod.	High	High
N-13	Malden Hill Brook Wetland, Holden	179		58					121	High	Mod.	N.R.	Mod.	Low
N-14	Pine Swamp, Boylston	80							80	High	Mod.	N.R.	Low	Mod.
B-1	Slocum Meadow, Shrewsbury	174							174	Mod.	High	N.R.	Mod.	Low
B-2	Hovey Pond Swamp, Grafton	144	10		3	92	10	29		N.R.	Low	Mod.	Mod.	Mod.
B-3	Cider Mill Swamp, Grafton	238		8		4		40	186	Mod.	Mod.	N.R.	High	Low
B-4	Cedar Swamp, Uxbridge	142					21	37	84	Mod.	Low	Mod.	Mod.	Mod.
B-5	Mill River Wetland, Mendon	168	55			20		18	95	Mod.	Low	N.R.	Mod.	Mod.
B-6	West River Wetland, Uxbridge	150			35	20	2	40	53	Mod.	N.R.	Mod.	Mod.	High
B-7	Rice City Pond Wetland, Northbridge, Uxbridge	105			50	45	10			N.R.	Low	Low	High	High
B-8	Hopedale Pond Wetland, Hopedale	138			14	68		34	22	High	Low	N.R.	High	High
T-1	Alder Meadows, Spencer	150				5			145	Mod.	Mod.	N.R.	Mod.	Mod.
T-2	Wallis Pond Wetland, Dudley	73				40			33	High	Mod.	N.R.	Mod.	Mod.
T-3	French River Wetland, Oxford	140			20		4	60	56	High	High	High	High	High
T-4	Robinson Pond Wetland, Oxford	140			40	40	40		20	Mod.	High	High	High	Mod.
T-5	Cedar Swamp, Monson	55							55	High	Low	N.R.	Low	Mod.
T-6	Stevens Swamp, Wales	75			10			35	30	High	Mod.	N.R.	Mod.	Mod.
T-7	Townline Swamp, Holliston, Sturbridge	100							100	High	Mod.	N.R.	Low	Mod.
T-8	Single Swamp, Brimfield	92							92	High	Low	N.R.	Low	Mod.
T-9	East Brimfield Reservoir Wetland, Brimfield	654			16		99	109	430	High	N.R.	High	High	High

to the effects of several closely associated wetlands; lose any of the group and the rating of the others will go up. Also, even a wetland which rates "Low" for all evaluated purposes should not be considered suitable for development. Because of the severe limitations imposed by wet conditions, all wetlands can also be rated "Low" for suitability for development. Flood hazards, year-round problems with standing water, foundation problems, and septic system failures are among the problems to be faced by those owning developed property located on former wetlands.

Public and quasi-public ownership and the zoning of privately owned wetlands are important facets of the wetlands picture in the region. Publicly and quasi-publicly owned wetlands are usually more secure from encroachment and development than privately owned areas. Many towns in the region have acquired wetlands as conservation areas. In other instances, state forests, parks, and wildlife areas encompass wetlands. Zoning bylaws can also be a major determinant of the future of a wetland. A wetland area zoned for industrial development is in much more danger than an area zoned as flood plain land.

Public ownership information has been obtained for all the wetlands of the region (Table 5.17). Public ownership and zoning has also been obtained for the 59 wetlands evaluated for various purposes. Wetland ownership and zoning data is presented in Table 5.18.

Some interesting conclusions can be drawn from the ownership and zoning data. Public or quasi-public ownership of the evaluated wetlands is over twice as high as for all wetlands. Included in the evaluated wetlands are the U.S. Fish and Wildlife Service's Great Meadows National Wildlife Refuge along the Sudbury and Concord Rivers, the Oxbow National Wildlife Refuge along the Nashua River, and Massachusetts Division of Fisheries and Wildlife's Pantry Brook Wildlife Management Area along the Sudbury River. Also, the U.S. Corps of Engineers' East Brimfield Reservoir constitutes over 90 percent of the public or quasi-public ownership within the evaluated wetlands of the Thames Study Area. In general the federal and state public agencies and the municipalities and quasi-public groups have concentrated their acquisition in the evaluated wetlands which are the largest and better known wetland areas of the region.

TABLE 5.17 OWNERSHIP, RESTRICTIONS, 1/ AND PROTECTIVE ZONING 2/ OF INLAND WETLANDS

Study Area	Total Area Inland Wetlands (acres)	Public & Quasi- Public Ownership (acres) % of Total ^{5/}	Inland Wetland Restrictions ^{3/} (acres) % of Total ^{5/}	Protective Zoning ^{4/} (acres) % of Total ^{5/}	Total Public Owner- ship Protective Zoning & Wetlands Restrictions (acres) % of Total ^{5/}
Merrimack	15,231	766 5.0	--	4,490 29.5	5,256 34.5
SuAsCo	27,216	5,160 19.0	691 2.5	9,040 33.2	14,891 54.7
Nashua	19,022	3,583 18.8	--	3,480 18.3	7,063 54.7
Blackstone	10,758	908 8.4	--	2,520 23.4	3,428 31.9
Thames	9,792	1,152 11.8	--	1,440 14.7	2,592 26.5
Totals	82,019	11,569 14.1	691 0.8	20,970 25.6	33,230 40.5

^{1/} Mass. GL Ch. 131, Sec. 40A

^{2/} Municipal flood plain conservancy, watershed protection or similar zoning which restricts development activity in wetlands.

^{3/} Publicly or Quasi-publicly owned wetlands have been subtracted from these figures.

^{4/} Publicly or Quasi-publicly owned and inland wetland restriction totals have been subtracted from these figures.

^{5/} Total area of subregion inland wetlands.

TABLE 5.18

EVALUATED WETLANDS SUMMARY

Study Area	Wetlands	Total Area (ac.)	Percent of Subregion's Wetlands	Area Public or Quasi-Public Owned (ac.)	(%)	Area Protectively Zoned (ac.)	(%)	Total Owned or Zoned (ac.)	(%)
Merrimack	17	3,442	22.6	376	10.9	1,731	50.3	2,107	61.2
SuAsCo	11	8,236	30.3	3,701	44.9	717	8.7	4,418	53.6
Nashua	14	2,387	12.5	806	33.8	506	21.2	1,312	55.0
Blackstone	8	1,259	11.7	167	13.3	151	12.8	328	26.1
Thames	9	1,479	15.1	699	47.3	58	3.9	757	51.2
Totals	59	16,803	20.5	5,749	34.2	3,173	18.8	8,922	53.1

5.6 WATER SUPPLY

Communities in the Central Region meet their municipal water supply needs from ground water sources or surface water supplies. In addition, seven municipalities purchase water from the Metropolitan District Commission which supplies Boston and neighboring suburbs in the Coastal Region. Many communities of the region rely to some degree on private individual supplies, wells, to meet total community water needs. There are 12 towns which have no municipal water supply and, therefore, rely entirely on private individual supplies (see Table 5.19).

5.7 IRRIGATION

Because the region has a well distributed rainfall of about 44 inches each year little irrigating is done. Areas being irrigated are generally high value nursery stock and some intensive produce operations. Few field crops require irrigation for successful production.

A total of only 800 acre-feet of water was used for irrigation in the Central Region in 1974. This is an average of less than .7 acre-foot per acre on the 1,200 acres irrigated in the region.

TABLE 5.19

EXISTING MUNICIPAL WATER SUPPLY

Municipality	Ground Water	Surface Water	Safe Yield (MGD)	Municipality	Ground Water	Surface Water	Safe Yield (MGD)
<u>Merrimack Study Area</u>				<u>Thames Study Area</u>			
Amesbury	X	X	1.5	Brimfield	-	-	- 1/
Andover	X	X	2.4	Charlton	-	-	- 1/
Burlington	X	X	7.7	Dudley	X	-	3.8
Chelmsford	X	-	8.3	Holland	-	-	- 1/
Dracut	X	-	3.2	Leicester	X	X	1.5
Dunstable	X	-	-	Oxford	X	-	2.4
Haverhill	-	X	8.7	Southbridge	-	X	2.9
Littleton	X	-	1.6	Sturbridge	X	-	2.0
Lowell	-	X	10.5	Wales	-	-	- 1/
Lawrence	-	X	14.0	Webster	X	-	3.5
Merrimac	X	-	0.5	<u>SuAsCo Study Area</u>			
Methuen	-	X	7.0	Acton	X	-	3.2
Salisbury	X	-	3.2	Ashland	X	-	2.0
Tewksbury	X	-	3.1	Bedford	X	-	1.8
Tyngsborough	-	-	- 1/	Berlin	-	-	- 1/
Westford	X	-	4.8	Billerica	X	X	7.0
W. Newbury	X	-	- 2/	Bolton	-	-	- 1/
<u>Nashua Study Area</u>				Boxborough	-	-	- 1/
Ashby	-	-	- 1/	Carlisle	-	-	- 1/
Ayer	X	-	1.5	Concord	X	X	5.0
Boylston	X	-	1.0	Framingham	X	X	2.3 4/
Clinton	-	-	- 3/	Hopkinton	X	-	0.6
Fitchburg	-	X	12.2	Hudson	X	X	2.3
Groton	X	-	0.8	Marlborough	-	X	2.0 4/
Harvard	X	-	0.06	Maynard	X	X	1.0
Holden	X	X	2.1	Northborough	X	-	1.1 4/
Lancaster	X	-	1.0	Shrewsbury	X	-	4.2
Leominster	X	X	7.6 4/	Southborough	-	X	0.4 3/
Lunenburg	X	-	0.8	Stow	X	-	0.8
Pepperell	X	-	2.1	Sudbury	X	-	3.1
Princeton	-	-	- 1/	Wayland	X	-	5.6
Shirley	X	X	1.2	Westborough	X	X	2.6
Sterling	X	-	0.5				
Townsend	X	-	0.5				
West Boylston	X	-	2.0				
Westminster	X	X	2.0				
<u>Blackstone Study Area</u>							
Auburn	X	X	2.7 5/				
Blackstone	X	-	0.9				
Douglas	X	-	0.5				
Grafton	X	-	2.3				
Hopedale	X	-	0.5				
Mendon	X	X	0.03 6/				
Millbury	X	-	3.8				
Millville	-	-	- 1/				
Northbridge	X	-	5.6				
Sutton	X	-	0.4				
Upton	X	-	0.4				
Uxbridge	X	-	2.8				
Worcester	X	X	32.5 4/				

1/ Private individual supplies only. 2/ All water from Groveland. 3/ Supplied entirely by MDC.
 4/ Additional supplied by MDC. 5/ Partially supplied from Worcester. 6/ Private company.

On the whole, irrigation is not a problem area. The ongoing program of the Soil Conservation Service is assisting growers to install irrigation systems, and other water management features. As a result, the topic of irrigation will not receive further consideration in this report.

5.8 DRAINAGE

Drainage systems have been installed on more than 432 acres of farmland in Worcester County. Little has been done elsewhere in the region. A study by Soil Conservation Service field office personnel indicates there are approximately 1,400 acres of additional farmland which could be significantly improved by drainage. Needs by Subareas are: Nashua, 500 acres; Blackstone, 400 acres; Thames, 300 acres; SuAsCo, 200 acres.

Drainage systems referred to are intended to improve production and reduce operating costs on existing farmland. Most of the systems installed in recent years have been underground drainage.

Regionally, drainage of agricultural land is considered a minor problem. The Soil Conservation Service is assisting farmers to install needed drainage systems. The Agriculture Stabilization and Conservation Service (ASCS) formerly provided cost sharing funds for drainage systems. For 1978, ASCS restricts cost sharing funds for drainage systems to just those systems which are used to control saline and/or polluted waters. It is expected that few if any proposed systems in Massachusetts will qualify for ASCS cost sharing funds. In addition, assistance from SCS and ASCS is limited to lands not in Wetland Types 3 to 20 as defined in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service. Therefore, drainage will not be discussed further in this report.

5.9 WATER QUALITY

According to the Massachusetts Division of Water Pollution Control, almost all of the major rivers in the region are effected by pollution to some

degree. The Nashua River and the Blackstone River were infamous for their poor water quality.

Statements about existing poor water quality in the region are subject to revision as each new wastewater treatment facility comes on line. So much has happened in the last 10 years--new secondary treatment plants, (some with advanced treatment), industrial wastewater treatment, (either tie-ups with municipal plants or treatment by the industry itself), and elimination of combined sewer problems.

Major planning efforts have brought about this change. In addition to the Massachusetts Division of Water Pollution Control ongoing programs and the efforts of communities and industries, three noteworthy programs should be mentioned: The Merrimack Wastewater Study, a coordinated effort led by the U.S. Army Corps of Engineers was completed in 1971; the Nashua River Program, a demonstration project by an inter-governmental team comprised of New England Regional Commission, New England Interstate Water Pollution Control Commission, New England River Basins Commission, Environmental Protection Agency, Massachusetts Division of Water Pollution Control, and New Hampshire Division of Water Pollution; and the Plan for the Nashua River Watershed and other efforts of the Nashua River Watershed Association.

At this time for much of the region, it is not known how much must be done beyond the levels of treatment presently being installed to meet the 1977 water quality requirements or the 1983 goals of PL 92-500, (the Federal Water Pollution Control Act Amendments of 1972). The 208 studies, discussed later, should be helpful with this question.

The Massachusetts Division of Water Pollution Control has established water quality standards for waters of the state (see Figure 5.12) and these are in the process of being revised. For purposes of this report, streams were rated using the following classification.

-Fresh Water-

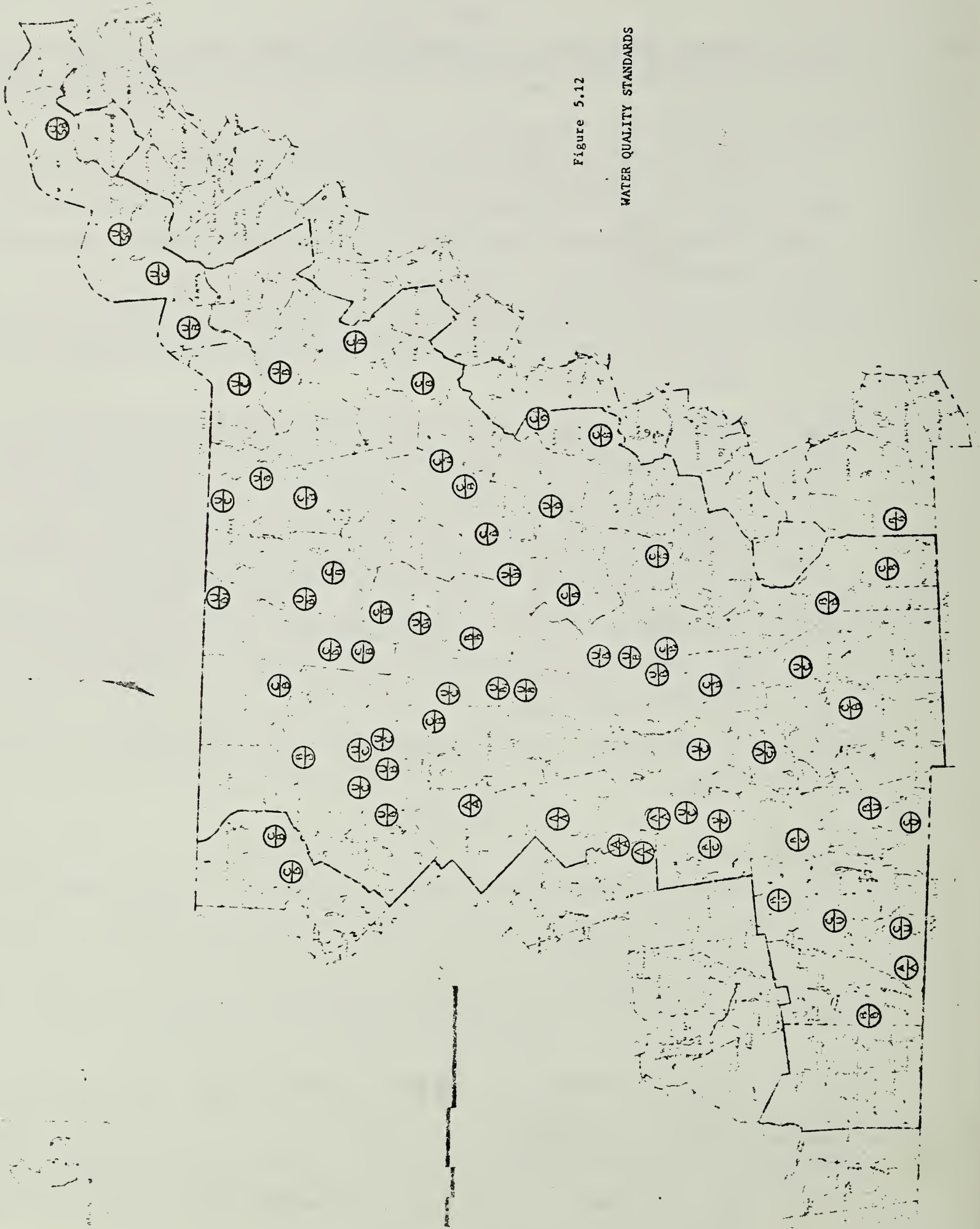
- Class A - Waters designated for use as public water supply in accordance with Chapter 111 of the General Laws. Character uniformly excellent.
- Class B - Suitable for bathing and recreational purposes including water contact sports. Acceptable for public water supply with treatment and disinfection. Suitable for certain agricultural and industrial uses; excellent fish and wildlife habitat; excellent aesthetic value.
- Class B1- The use and criteria for Class B1 shall be the same as for Class B with the exception of the dissolved oxygen criteria, which is lower than Class B.
- Class C - Suitable for recreational boating and secondary water contact recreation; habitat for wildlife and common food and game fishes indigenous to the region; certain agricultural and industrial uses; under some conditions acceptable for public water supply with treatment and disinfection. Good aesthetic value.
- Class C1- The use and criteria for Class C1 shall be the same as for Class C with the exception of the dissolved oxygen criteria, which is lower than Class C.
- Class U - Unsatisfactory river conditions not capable of meeting "C" standards.

-Salt Water-

- Class SA- Waters of the highest quality. Suitable for any use including bathing or other water contact activities. Suitable for approved shellfish areas. Highest aesthetic value and excellent fish and wildlife habitat.
- Class SB- Waters suitable for bathing and recreational purposes, water contact sports, and industrial cooling. Good aesthetic values, excellent fish habitat. Suitable for certain shell fisheries (restricted shellfish areas).
- Class SC- Suitable for aesthetic enjoyment, recreational boating, as a habitat for wildlife and common food and game fish indigenous to the region, and for certain industrial uses.

Figure 5.12

WATER QUALITY STANDARDS



Sources of water pollution are normally placed into two major categories: point, or nonpoint sources.

Point sources are those where a large quantity of pollutants are discharged into a stream from a discrete, readily identifiable source. The most common examples of point sources include discharges from wastewater treatment plants and industrial plants.

Nonpoint sources are more difficult to isolate. They usually involve relatively small quantities of pollutants which are discharged over relatively large areas. Examples of nonpoint sources include urban runoff, such as salt runoff and litter from streets, animal wastes from agricultural enterprises, sediment from accelerated erosion problem areas, fertilizer and pesticide runoff from agricultural use, effluent from inadequate septic systems, and leachate from poorly situated or managed landfills or dumps. Pesticide use is regulated by the Pesticides Board, Massachusetts Department of Environmental Quality Engineering.

Merrimack River -- The Merrimack River is below its "C" classification when it enters Massachusetts from New Hampshire due to discharges in New Hampshire, and from the Nashua River which joins the Merrimack a few miles upstream of the state line. Within Massachusetts the discharges at Lowell, Lawrence, and Haverhill, which are greatly in excess of the pollution loading in the river at the state line, ensure that the Merrimack remains below its classification for its entire length in Massachusetts. Over 100 million dollars has been spent for improvements in wastewater treatment facilities by the Massachusetts communities of the study area. In addition, the industrial sector is also heavily involved in pollutant abatement.

Nashua River -- The Nashua River had been identified as one of the most grossly polluted streams in New England. The water quality problems originate in the Fitchburg-Leominster area at the headwaters of the North Nashua River. These poor quality conditions continue to the confluence

with the South Nashua River in Lancaster, and further to the confluence with the Merrimack River in Nashua, New Hampshire. Prior to the water quality sampling by the Massachusetts Division of Water Pollution Control in the summer of 1977, most major stream reaches were below water quality stream standards.

Major improvements have recently been made in the watershed due to the recently completed wastewater treatment facilities, some of which supply advanced treatment in excess of secondary treatment. However, until all of the planned facilities are on line and operating to design efficiencies, problems will persist.

SuAsCo River -- The SuAsCo consists of the Concord River, and its two principal tributaries, the Assabet and Sudbury Rivers. All three rivers do not meet presently assigned water quality standards.

In the Assabet River the spacing of the six municipal secondary wastewater treatment plants is such that the river never gets a chance to recover before it receives an additional discharge of pollutants. Higher degrees of treatment will be needed before the Assabet will meet its assigned water quality standards.

The Sudbury and Concord Rivers do not have as serious a point source problem as the Assabet, but the sluggish flow of the Sudbury and Concord Rivers is not conducive to quick assimilation of pollutants. In addition, bordering meadowlands, and wetlands contribute materials which place an additional oxygen demand in these rivers.

Blackstone River -- The Blackstone River has long been one of the Commonwealth's most polluted rivers. This situation has developed because of the large population and many industries i.e., city of Worcester and neighboring towns, located in the extreme upstream portion of the watershed.

Downstream of Worcester, domestic and industrial discharges add sufficient pollutants so that the river is unable to recover, and remains polluted to the Rhode Island line and below.

The Upper Blackstone Water Pollution Abatement District has recently constructed a new wastewater treatment facility, which Worcester and Auburn use. The towns of Leicester, Paxton, Rutland, West Boylston, Boylston, and Shrewsbury are in the district and may in the future, use this facility. Downstream, numerous towns have installed secondary treatment facilities and industries have installed treatment facilities also. Even with the large expenditure in treatment facilities, water quality of the Blackstone River is still below the state stream standards.

French and Quinebaug Rivers (Thames River) -- The French and Quinebaug Rivers are tributaries of the Thames River which begins at the confluence of the French and Quinebaug in Connecticut. In the Massachusetts portion of this basin, all major point sources of pollution receive some degree of treatment. All the municipal discharges receive secondary treatment. However, analyses by the Massachusetts Division of Water Pollution Control indicate that advanced treatment will probably be necessary to meet stream water quality classifications on Cady Brook from Charlton City to the confluence with the Quinebaug River, on the Quinebaug River below the Southbridge wastewater treatment plant to the state line, and on the French River downstream of the Leicester treatment plant (particularly in Dudley and Webster).

Section 208 of Public Law 92-500, the Water Pollution Control Act, Amendments of 1972, authorized the preparation of Water Quality Management Plans for designated areas of the country. In the Central Region, most of the towns are within a designated "Areawide Waste Treatment Management Area." See Figure 5.13 for the location of these areas.

Major objectives of most of these "208" studies will be to assess the effectiveness of the installed or planned treatment of point pollution sources and the evaluation of the magnitude and seriousness of the nonpoint problem. Tentative solutions to water quality problems will also be formulated. Studies in other parts of the United States have shown that nonpoint sources may produce half of the pollution observed. The "208" studies will attempt to determine how true this is for the Central Region.



Metropolitan Area Planning Council



Montachusett Regional Planning Commission



Central Massachusetts Regional Planning Commission



Northern Middlesex Area Commission



Rhode Island Statewide Planning Program

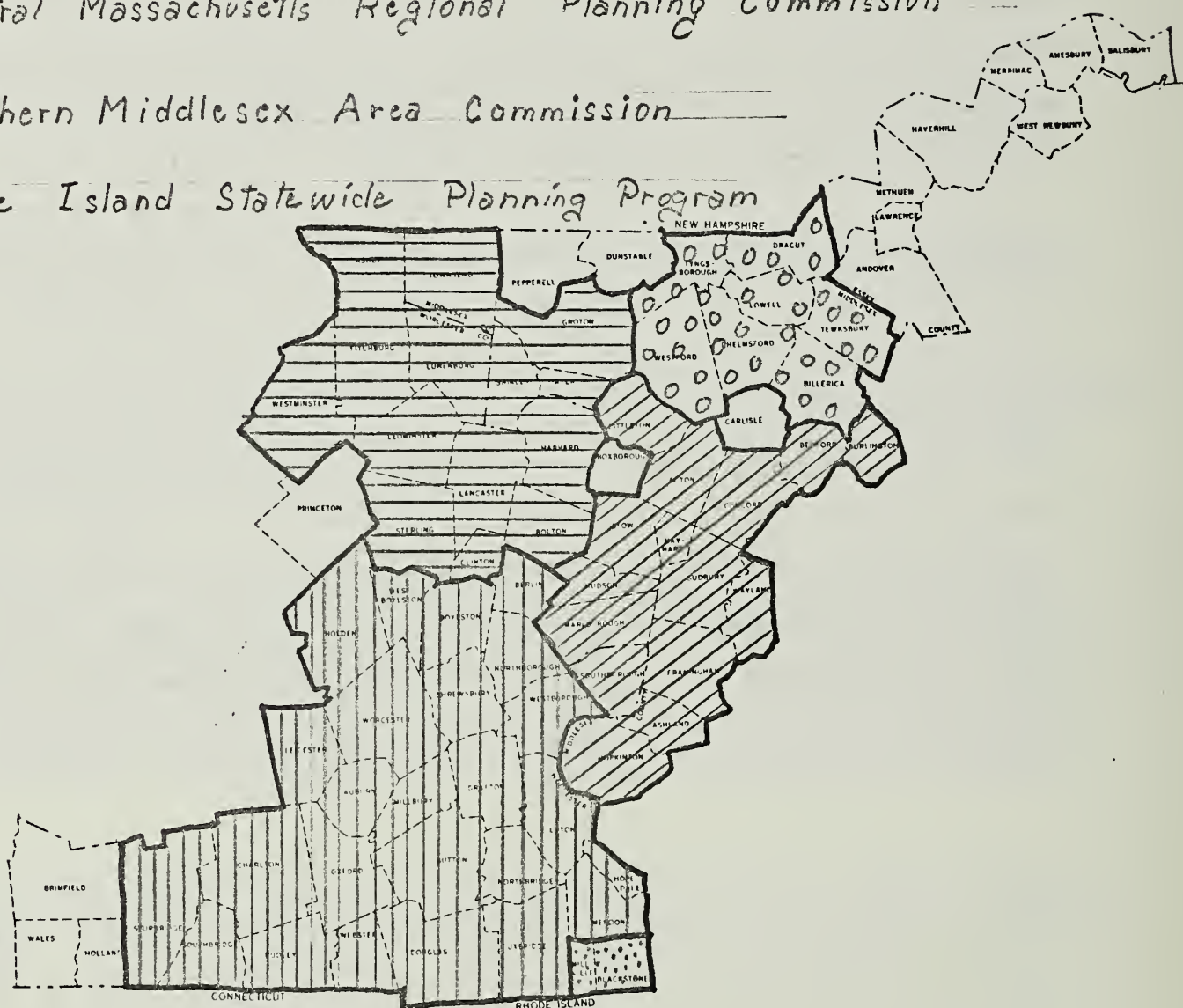


Figure 5.13

DESIGNATED AREAWIDE WASTE TREATMENT MANAGEMENT AREAS

Individual subsurface sewage disposal systems are relied on exclusively in many areas. Even in towns with some municipal sewer service, residents in outlying areas must make use of individual septic tank-leach field systems.

In most cases, an adequately designed individual disposal system is able to treat and dispose of domestic sewage with little adverse effect on the ground water. Unfortunately, many of the older systems in the region are inadequately designed and fail to remove significant amounts of nutrients such as phosphates and nitrates. An additional problem can be the adequate disposal of sludge from septic tank cleanouts.

In addition, soil conditions in much of the area are unsuitable for septic tank systems. Table 5.20 indicates results extracted from detailed soil surveys in 41 of the region towns. Limitations are due to seasonally high water table, bedrock or hardpan, and low soil permeability, these being the most common limitations on the use of individual disposal systems. A large percentage of the developable land in these towns has "severe" limitations for onsite septic tank disposal systems.

Agriculture-related pollution can result from two main sources: animal wastes, and runoff containing residues of fertilizer, pesticides, and herbicides. In the Central Region cattle, hogs, and chickens represent the largest potential source of animal waste pollution. Unless properly managed, animal wastes present a water quality hazard. In the Central Region animal waste is not a dominant pollution source because of the size of farms in the area and their location in relation to watercourses. Heavy use of commercial fertilizer is another agriculture-related nonpoint source of pollution. Fertilizer which is not utilized by crops can become a potential hazard if washed into waterways, ponds, or lakes. The high cost of fertilizer and the relatively low-value crops tend to minimize fertilizer as a significant pollution source.

Table 5.20 - Limitations for Onsite Septic Tank Disposal Systems
(from Town Soil Reports)

City/Town	Area Mapped	Excluded Areas	Water	Limitations for Septic Tanks			Percent of Mapped Area with Severe Limitation
				Unclassified	Slight	Moderate Severe	
			- - - - - ACRES	- - - - -	- - - - -		
Merrimack River Basin							
Amesbury	8,850	0	832	271	1,110	436	6,201
Andover	20,474	7,525	669	818	1,978	1,734	7,750
Burlington	7,603	0	31	437	637	110	6,388
Chelmsford	14,694	0	327	1,326	3,783	1,316	7,942
Haverhill	22,931	5,085	982	816	1,299	794	13,955
Littleton	11,098	0	615	736	1,577	619	7,551
Merrimac	5,491	0	172	205	703	539	3,872
Methuen	14,317	4,277	111	562	829	1,651	6,887
Salisbury	10,323	2,590	194	322	1,009	157	6,051
Tewksbury	13,382	0	213	933	3,537	939	7,760
Tyngsborough	11,647	0	837	436	1,363	2,429	6,582
Westford	19,840	0	654	1,090	3,404	3,145	11,547
West Newbury	9,382	935	0	31	247	169	8,000
Nashua River Basin							
Ayer	5,978	1,995	346	153	829	202	2,453
Boylston	12,633	3,968	187	172	504	443	7,359
Fitchburg	18,108	0	276	1,800	1,241	1,691	13,100
Harvard	13,829	0	387	160	754	388	12,140
Holden	23,176	0	975	572	2,586	1,671	17,372
Leominster	18,883	0	653	1,310	2,802	1,782	12,336
Pepperell	14,960	0	385	482	2,096	1,144	10,853
Princeton	22,850	4,010	208	90	814	1,846	15,882
Shirley	10,170	674	169	189	1,958	1,026	6,154
Sterling	20,267	0	816	249	2,325	1,221	15,656
Townsend	21,013	5,335	206	160	3,406	2,945	8,961
Westminster	23,745	3,848	978	525	1,173	2,390	14,831
							80.6

Table 5.20.- Limitations for Onsite Septic Tank Disposal Systems
(from Town Soil Reports)

City/Town	Area Mapped	Excluded Areas	Water	Unclassified	Limitations for Septic Tanks			Percent of Mapped Area with Severe Limitation	
					ACRES	Slight	Moderate		Severe
Blackstone River Basin									
Douglas	24,371	0	774	122	1,474	8,736	13,265	54.5	
Grafton	14,925	0	410	775	1,658	2,140	9,942	72.3	
Northbridge	11,494	0	597	490	1,091	1,588	7,728	74.2	
Thames River Basin									
Sturbridge	24,934	0	1,200	863	1,618	1,523	19,730	86.3	
SuAsCo River Basin									
Ashland	8,295	0	360	400	634	1,091	5,810	77.1	
Bedford	8,864	0	117	1,409	416	107	6,815	92.9	
Berlin	8,435	0	144	324	1,263	633	6,071	76.2	
BillERICA	16,618	0	351	1,087	4,023	354	10,803	71.2	
Bolton	12,851	0	144	442	1,607	872	9,786	79.8	
Boxborough	6,656	0	13	178	500	322	5,643	87.3	
Concord	16,492	0	640	684	3,881	881	10,406	68.6	
Hopkinton	16,653	0	0	688	828	2,471	12,666	79.3	
Hudson	7,462	0	192	661	1,657	490	4,462	67.5	
Northborough	11,981	0	183	448	2,307	1,151	7,892	69.5	
Stow	10,430	0	407	127	2,207	626	7,063	71.4	
Westborough	7,770	0	77	280	507	189	6,717	90.6	

Forest management activities can also cause nonpoint pollution problems. This is true where such activities as recreation, timber management, grazing, road and trail construction, and timber harvesting may occur. Certain water quality parameters, including water temperature, turbidity, total dissolved solids, nitrate-nitrogen, and fecal coliforms, may all be affected by the manner in which the watershed is managed. The severity is dependent on the particular management activities and the percentage of the watershed affected by the activities. Through proper planning, the effects of land management on water quality can be minimized.

5.10 FISH & WILDLIFE

5.10A Fish

Fishery resources in the Central Region include warm and cold water fish populations living in freshwater ponds, lakes, and streams, and anadromous species which spawn in fresh water but spend part of their lives at sea.

The most sought-after game fish are the cold water species such as the brook trout, the introduced brown trout, lake trout, and rainbow trout. Many ponds and over 100 streams in the Central Region are stocked with these species (see Tables 5.21 and 5.22). Artificial propagation and stocking are an attempt to meet the angling demand which grows continually while suitable habitat diminishes. Trout do not reproduce effectively in Massachusetts waters. They require cool waters with adequate levels of dissolved oxygen; a year-round condition that exists in very few streams. The heat of summer is limiting.

Warm water fishing in the region (and in the state as a whole) is not dependent upon artificial rearing and stocking. Bass, pickerel, and such panfish as white and yellow perch, bluegills, bullheads, and crappies can be caught. The populations of these panfish species could support more fishing pressure than they now receive.

Table 5.21 - Summary of Streams

River Basin	Miles of Stream	Number of Streams Stocked Annually with Trout
Merrimack	305	23
Nashua	378	37
Blackstone	237	18
SuAsCo	307	18
Thames	<u>152</u>	<u>12</u>
	1379	108

Table 5.22 Summary of Inventory of Ponds, Lakes, and Reservoirs
20 Acres and Over in Size^{1/}

Item	Unit	Subregion					Region Totals
		Merrimack	SuAsCo	Nashua	Blackstone	Thames	
Ponds, Lakes & Reservoirs	No.	43	52	71	47	47	260
	Ac.	4135	6648	9980	4194	5108	30,065
Cold Water Fisheries	No.	3	5	10	1	4	23
	Ac.	239	896	955	322	1505	3,917
Warm Water Fisheries	No.	40	47	61	46	43	237
	Ac.	3896	5752	9025	3872	3603	26,148
No Access, Private	No.	14	12	7	7	8	48
	Ac.	821	620	340	538	712	3,031
No Access, Public Water Supply	No.	8	10	11	0	4	33
	Ac.	1314	2113	1225	0	261	4,913
Informal or Municipal Access	No.	17	18	47	36	27	145
	Ac.	1371	1496	3447	2618	1830	10,762
Full Public Access	No.	4	12	6	4	8	34
	Ac.	629	2419	4968	1038	2305	11,359

^{1/}Major Data Source - Inventory of the Ponds, Lakes, and Reservoirs of Various Counties by James A. McCann et al, Water Resources Research Center, University of Massachusetts, Amherst, Massachusetts, 1972.

Atlantic salmon and American shad are native anadromous species which are being restored to the Merrimack River. When restored, salmon and shad will constitute an outstanding fishery resource. They, and other outstanding fishery resources in the region are discussed in Section B.

5.10B Outstanding Fishery Resources

Anadromous Fish Restoration, Merrimack River -- A concentrated cooperative effort involving the states of Massachusetts and New Hampshire, and federal and private agencies, is underway to restore Atlantic salmon and American shad to the Merrimack River. The Atlantic salmon is a particularly prized gamefish, and a run of 11,000 in the Merrimack is anticipated when restoration is accomplished.

Prior to the 19th century, the river supported great runs of salmon and shad, an abundant and unfailing source of food to the Indians and later to the early colonists. In 1789, it was not uncommon for a man to seine 60 to 100 salmon per day from the lower river. But as industry developed in New England, dams built to provide power and to allow navigation past rapids succeeded in cutting the anadromous fish off from their upstream spawning grounds and the lower river became seriously polluted. By 1859, the salmon was completely gone from the Merrimack, and only a tiny remnant of the shad persisted./

An initial attempt to restore anadromous fish to the Merrimack Watershed failed and was abandoned in 1898. The present effort dates from 1966 and has accomplished much. The river is cleaner now, studies of the river have been completed, and efficient fishways are being planned for the dams at Lawrence and Lowell in Massachusetts and Amoskeag, Hooksett, and Garvin Falls in New Hampshire. In the spring of 1976, a release of 2,500 hatchery-reared Atlantic salmon smolts was made.

Nissitissit and Squannacook Rivers -- The Nissitissit and Squannacook Rivers provide excellent cold water fisheries in the Central Region. They both originate in New Hampshire and join the Nashua River, (the Nissitissit joining in Pepperell and the Squannacook in Shirley). The feeder streams of the Squannacook River are also very good trout streams.

Wachusett Reservoir -- Wachusett Reservoir (in Boylston, West Boylston, Sterling, and Clinton) offers a unique trophy fishery, principally for brown trout, rainbow trout, and lake trout. The all-time state record brown trout (19 pounds, 10 ounces) was taken from the reservoir in 1966. Fishing from the shore is the only type allowed, and a permit from the Metropolitan District Commission is required. There is good fishing for large and small-mouthed bass, in addition to trout.

Northern Pike -- Northern pike have been introduced at two locations in Worcester County and are stocked there annually. Pike were introduced 4 years ago into the Quinebaug River, East Brimfield Reservoir, and Holland Pond system and 2 years ago into the Quaboag River and South Pond in the Connecticut River Region. There has been no evidence of reproduction yet.

5.10C Wildlife

The Central Region of Massachusetts provides habitat for a variety of wildlife species, including resident species, migrants which are regular visitors, and others, such as moose, which occasionally wander in. The number of different ecological niches available for the species to fill is related to the geographic location of the region and the physiographic variation within it. Ecosystem types range from sand beaches at Salisbury to the pervasive upland forest which covers most of the region.

The greatest value of the wildlife species in the region, like those anywhere, is in their simply continuing to exist and perform their roles in

the natural scheme of things. More obviously, we enjoy their existence in several ways, as Section D discusses.

The location of different species in the region is determined in large part by the use to which the land is put and by the resulting vegetative cover. Tables in Section E show acreages of various land uses and cover types in the Central Region, as well as species of plants and animals which are found there. Trends in land use in the region emphasize the importance of efforts to retain or improve remaining wildlife habitat. To retain a varied animal population, it is important that their habitat be neither unbroken forestland nor fully developed urban land.

A number of species exist in limited numbers in the state and in the region. Their scarcity raises concern over the environmental conditions which are thought to be causing their declining numbers. Section F discusses scarce species, and outstanding wildlife areas within the region.

5.10D Value and Use of Wildlife Resources

The greatest value of wildlife resources is that, like man, each species is a part of an ecosystem. Each has its own role. Life depends on the adequate functioning of the whole, and knowledge of the interrelationships involved is still incomplete. Altering the size of wildlife populations by habitat modification or by other means may produce unpredictable consequences.

A secondary value of wildlife is for public recreation and its utility for both food and clothing. Wildlife is enjoyed in both consumptive and non-consumptive ways.

Consumptive -- Approximately 2.4 percent of the Massachusetts population participates in hunting game species in the Commonwealth. Harvestable game species in the Central Region include white-tailed deer, black bear, snowshoe hare, cottontail rabbit, gray squirrel, opossum, raccoon, bobcat,

red and gray fox, pheasant, ruffed grouse, woodcock, and waterfowl. They are all hunted in accordance with seasonal or daily bag limits. The following species may be taken at any time and in any numbers: house sparrow, chipmunk, flying squirrel, red squirrel, weasel, porcupine, striped skunk, and woodchuck. The discharge of firearms is prohibited by town ordinance in Burlington and Lowell and is restricted in 18 other towns in the Central Region.

Statewide hunter preference for various game species, in descending order of importance, with notes on habitat and numbers, are as follows:

Pheasant - Agricultural land well interspersed with brushland, swamps, and small woodlots. Stocked annually to supplement wild populations. There is excellent pheasant hunting in the Worcester County portion of the region, fair hunting in the remainder.

Deer - Forested land in various stages of succession, interspersed with swamps and open land. Deer hunting varies from fair to poor in the region.

Ducks and Geese - Coastal and inland wetlands, permanent open waters. The best opportunities for hunting migratory waterfowl in the region are found in Worcester County, where heavily used areas include the Quaboag River and marshes, the Blackstone, Nashua, and Assabet Rivers, and many beaver flowages. The Delaney and Nichols multiple purpose waterfowl impoundments also provide good waterfowl hunting opportunity.

Ruffed Grouse - Forestland in various stages of succession, well interspersed with old fields, orchards, and swamps. Hunting for ruffed grouse in the region is considered "average."

Cottontail Rabbit - Agricultural land well interspersed with brushland, swamps, and small woodlots. Fair hunting.

Woodcock - Woodland areas containing much alder and aspen and fairly clear of heavy ground cover. There is excellent woodcock hunting in the Worcester County portion of the region.

Gray Squirrel - Hardwood forests containing mature oak and hickory trees. Excellent squirrel hunting in the Worcester County portion of the region, average in the remainder. A much smaller number of Massachusetts residents engage in trapping than in hunting. Beaver, muskrat, otter, raccoon, mink, opossum, fox, skunk, weasel, bobcat, and fisher may be trapped.

Annual values of wildlife harvested in the state amount to about \$3.5 million for food, and \$0.5 million for fur.

Nonconsumptive -- Nonconsumptive recreational uses of wildlife resources include bird watching, nature study, and wildlife photography. The Central Region of Massachusetts provides a great variety of habitat types in which wildlife can be observed and photographed.

Some public lands are used extensively for these activities. The Great Meadows National Wildlife Refuge, with headquarters in Concord, comprises approximately 2,700 acres of marsh, impoundments, river bottomland and woodland. Migrating and wading waterfowl and other birds may be seen there. Other popular spots for bird-watching are the Bolton Flats Wildlife Management Area in Bolton, which is predominantly agricultural river bottomland, traversed by two rivers, and is attractive to a variety of songbirds, and the George Nichols Reservoir, (a PL 83-566 site) in Westborough which is noted for shorebirds, waterfowl, and Great Blue Heron nesting.

Nonconsumptive use of wildlife resources exceeds consumptive use on wildlife management areas of the Division of Fisheries and Wildlife.

5.10E Land Uses and Vegetative Cover

Wildlife populations in an area are intimately related to the land use and vegetative cover. Species have different needs for food, protective cover, and nesting or resting sites, which must be satisfied by their habitats if the animals are to survive. Wildlife resources in the Central Region include forest species, wetland species, and open land or agriculturally-related species. There are also some species which can live in urban and suburban environments. Table 5.23 gives acreages of the present land use and vegetative cover types in each of the study areas of the Central Region. Table 5.24 lists the vegetation and wildlife associated with the more important cover types in the region.

About 57 percent of the Central Region is in upland forest types. The forest wildlife habitat may be composed primarily of hardwood trees, softwood trees, or a combination of both. The forest stand, of whichever type, can vary in height, in density, and in the understory and ground cover vegetation associated. Those differences all affect the types and numbers of wildlife present.

Open land wildlife are those species which prefer open agricultural land or land which has recently been abandoned that is beginning to revert to woodland through natural plant succession. The category agricultural land includes tilled or tillable cropland, hayland, pasture, orchards, nurseries and greenhouses, and cranberry bogs. Abandoned agricultural land includes abandoned fields and orchards in some stage of plant succession in which grasses, forbs, and shrubs are still found. About 12 percent of the Central Region is used in agriculture or abandoned agriculture.

Wetlands comprise about 13 percent of the Central Region. Of the different types of wetlands, 49,300 acres of wooded swamps (Type 7), cover the largest area. Wooded swamps provide high value food and cover to woodcock, cottontail rabbit, hare, and deer and are important as nesting and feeding areas for wood and black ducks when the swamp borders open water. The other wetland types are listed below in order of decreasing total area, with notes about their importance to wildlife.

TABLE 5.23- Land Use and Vegetative Cover^{1/} (acres)

	Merrimack	Nashua	Study Area Blackstone	SuAsCo	Thames	Total	Percent of Region
Urban	57,042	32,936	34,543	54,392	10,357	189,270	18
Hardwoods	40,821	66,785	55,034	49,518	56,605	68,763	25
Softwoods	9,701	27,015	3,409	7,688	6,073	53,486	5
Mixed Hardwood & Softwood	39,583	94,223	42,402	60,262	46,617	283,087	27
Agriculture	21,634	27,576	15,406	22,826	15,631	103,073	10
Abandoned Agriculture	9,486	8,539	4,416	8,881	5,774	19,071	2
Power Lines	1,212	2,336	1,835	549	813	6,787	1
Wetland Types 2/3/							
Wetland Types 1 & 2	1,684	1,159	704	2,470	414	6,431	1
Wetland Types 3 & 4	2,086	1,957	1,473	2,651	1,102	9,269	1
Open Fresh Water, Type 54/	4,285	10,579	4,437	31,724	5,870	42,031	4
Wetland Types 6 & 8	2,464	1,361	1,406	3,968	702	9,901	1
Wetland Type 75/	8,854	14,640	7,175	34,553	7,574	49,302	5
Saltwater Wetlands	2,527	-	-	-	-	2,527	-
Total Wetlands	(15,231)	(19,022)	(10,758)	(82,019)	(9,792)	(136,822)	(13)
Heath	-	-	-	7	-	7	-
Sand	-	29	14	15	-	58	-
Recreation	3,164	1,874	1,651	3,343	951	10,983	1
Mining or Waste Disposal	2,532	1,729	1,733	2,612	706	9,312	1
Total	206,675	292,738	175,638	285,499	159,191	1,063,358	

^{1/} Based primarily on information provided by W.P. MacConnell, et al. Remote Sensing 20 Years of Change, Massachusetts Agricultural Experiment Station, University of Massachusetts at Amherst, 1974.

^{2/} Shaw, S.P. and C.G. Fredine. Wetlands of the United States, Circular 39, Fish and Wildlife Service, U.S. Department of the Interior, U.S. Government Printing Office, Washington, D.C., 1971.

^{3/} The categories presented here are: Type 1 - Seasonally flooded basins or flats
Type 2 - Inland fresh meadows
Type 3 - Inland shallow fresh marshes
Type 4 - Inland deep fresh marshes
Type 5 - Inland fresh open water
Type 6 - Shrub swamps
Type 7 - Wooded swamps
Type 8 - Bogs

^{4/} Acreages derived by subtracting river areas from MacConnell's figures for open water.

^{5/} Wooded swamps could not be distinguished in MacConnell's analysis of aerial photography. These figures were derived by measuring areas marked by the swamp symbol on topographic maps in areas designated as forest by MacConnell.

TABLE 5.24 Land Cover and Associated Vegetation and Wildlife

Land Cover Type	Acres	Percent of Land in Region	Vegetation Associated with Cover Type		Wildlife Associated with Cover Type		
			Trees/Woody Plants	Understory Plants/Nonwoody Plants	Mammals	Birds	Reptiles, Amphibians
Hardwood	268,763	25	northern red oak	witch hazel	eastern chipmunk	ruffed grouse	spring peeper
			white oak	arrowwood	eastern cottontail	blue jay	eastern garter snake
Softwood	53,486	5	shagbark hickory	hobblebush	raccoon	screech owl	northern black racer
			red maple	wild raisin	striped skunk	crow	eastern milk snake
			scarlet oak	sarsaparilla	opossum	black-capped chickadee	American toad
			American basswood	partridgeberry	whitetail deer	slate-colored junco	
			sugar maple		white-footed mouse		
			white ash		shorttail shrew		
			white birch		hairytail mole		
			American beech		star-nosed mole		
			black locust		gray squirrel		
			quaking aspen				
			black cherry				
			American elm				
			yellow birch				
Mixed Hardwood and Softwood	283,087	27	white pine	honeysuckle	red squirrel	black-capped chickadee	
			pitch pine	witch hazel	gray squirrel	downy woodpecker	
Wetland - Fresh Water	134,295	13	eastern hemlock	mountain laurel	northern flying squirrel	hairy woodpecker	
			red pine in plantations		eastern chipmunk	white-breasted nuthatch	
					shorttail shrew	blue jay	
					star-nosed mole	slate-colored junco	
					white-footed mouse	starling	
					opossum	crow	
					whitetail deer		
Mixed Hardwood and Softwood	283,087	27	red maple	honeysuckle	red squirrel	ruffed grouse	spring peeper
			red oak	silky dogwood	northern flying squirrel	black-capped chickadee	eastern garter snake
Wetland - Fresh Water	134,295	13	white pine	raspberry	gray squirrel	downy woodpecker	northern black racer
			white ash		eastern chipmunk	hairy woodpecker	eastern milk snake
			black cherry		eastern cottontail	blue jay	American toad
			American elm		raccoon	slate-colored junco	red-backed salamander
			American basswood		striped skunk	crow	
					opossum		
Wetland - Fresh Water	134,295	13	red maple	arrowwood	muskrat	wood duck	wood hog
			black gum	alderberry	mink	black duck	spring peeper
Wetland - Fresh Water	134,295	13	Atlantic cedar	high bush blueberry	beaver	mallard duck	bullfrog
			speckled alder	silky dogwood	otter	catbird	leopard frog
			black birch	poison ivy	little brown myotis	cedar waxwing	green frog
			yellow birch	jewelweed		woodcock	eastern garter snake
			willows	reed canarygrass		tree swallow	northern black racer
				reeds			spotted turtle
				sedges			eastern painted turtle
				brasses			wood turtle
				cattail			spotted salamander
							red-backed salamander

TABLE 5.24 · Land Cover and Associated Vegetation and Wildlife

Land Cover Type	Acres	Percent of Land in Region	Vegetation Associated with Cover Type		Wildlife Associated with Cover Type		
			Trees/Woody Plants	Understory Plants/Nonwoody Plants	Mammals	Birds	Reptiles, Amphibians
Open Land (Agricultural Land)	103,073	10	trees grown include domestic fruit trees, ornamental shrubs, and Christmas trees	crops and forage grown include silage, corn, vegetables, alfalfa and grasses	meadow vole shorttail shrew star-nose mole woodchuck whitetail deer striped skunk eastern cottontail	goldfinch meadowlark field sparrow mourning dove ring-necked pheasant red-winged blackbird cowbird starling grasshopper sparrow	eastern garter snake American toad
Open Land (Abandoned Agricultural Land)	19,071	2	silky dogwood gray dogwood pasture juniper red maple gray birch high bush blueberry low bush blueberry	goldenrod milkweed hawkweed timothy fescue	eastern cottontail red fox striped skunk woodchuck eastern chipmunk whitetail deer shorttail shrew meadow vole	goldfinch red-winged blackbird cowbird ring-necked pheasant mourning dove starling	eastern smooth green snake eastern garter snake eastern milk snake northern black racer American toad
Urban	189,270	18	ornamental trees	grasses ornamental herbs and shrubs	Norway rat house mouse gray squirrel shorttail shrew eastern mole	rock dove starling English sparrow nighthawk grackle	
Power Lines	6,787	1	trees which do not interfere with primary land use	grasses low shrubs	eastern cottontail	rufous-sided towhee slate-colored junco ruffed grouse	eastern garter snake northern black racer eastern milk snake American toad common newt spotted salamander
Recreation	10,983	1					
Mining or Waste Disposal	9,312	1					

Open Fresh Water (Type 5) - May produce aquatic vegetation of high value to waterfowl; provides food and cover for muskrat, beaver, and otter and food for mink and raccoon. There are approximately 42,000 acres in the region.

Seasonally Flooded Basins or Flats (Type 1) and Inland Fresh Meadows (Type 2) - Seasonally flooded areas are utilized by waterfowl for feeding when flooded; fresh meadows are used as feeding grounds and for nesting with favorable conditions. Both types provide food for deer during summer and fall, year-round food for fox, skunk, weasel, and raccoon, and food and cover for pheasant. There are approximately 6,400 acres of Type 1 and 2 in the region.

Inland Shallow (Type 3) and Deep (Type 4) Marsh - Shallow fresh marsh is a very important type, used by waterfowl for nesting and feeding; deep fresh marsh is the most important inland type; it is used for feeding and, in some cases, nesting by waterfowl; both types provide food and/or cover to muskrat, mink, and a variety of other species. There are approximately 9,300 acres of Type 3 and 4 in the region.

Shrub Swamps (Type 6) and Bogs (Type 8) - Important to waterfowl when it borders permanent open water; shrub swamps provide high value food and cover to woodcock, cottontail, hare, and deer, and food and/or cover to other species. There are approximately 9,900 acres of these two types in the region.

The kinds of plants found in wetlands in the region vary widely, and depend on the depth of water, period of flooding, or stage of plant succession. Nearly all types of land, and uses of land, support or allow some wildlife species. The greater the habitat diversity, the greater the diversity of wildlife species. Edge, between different types of cover, such as field, forest, or wetland is extremely valuable to wildlife because it provides nearby food and cover.

Land uses and vegetative cover are not static. Changes occur both with and without human action and those changes can drastically alter the size and

composition of wildlife populations. Natural succession gradually changes vegetative cover, moving it in stages toward the climax condition for the particular location. Abandoned agricultural fields grow up into young forests. Young forests mature and age to become old forests. Without some intervention, such as fire, timber harvest, or some sort of land clearing, natural succession effectively eliminates open land and, leads to the elimination of wildlife species which require or prefer open land. In addition, as lands become increasingly forested, diversity is reduced, and as a result numbers and variety of the wildlife species they contain is reduced. This progression toward unbroken forest is a major trend in Massachusetts today.

Working in opposition to that trend is a man-caused trend toward the development of all lands easily built upon for residential, commercial, or industrial uses. These easily built-upon lands are usually agricultural or abandoned agricultural lands. In Worcester County, agricultural and open lands dropped from 22 percent to 13 percent of the county between 1951 and 1971, while highway commercial land use increased 270 percent and 696 acres of new shopping centers were built. When such development occurs open land habitat, and essentially all wildlife habitat are eliminated.

If Massachusetts is to retain or increase the numbers, and variety of wildlife species which it now supports, efforts must be made to provide the necessary diversity, and land suitable for habitat. Preservation of farmland and more active timber harvesting programs are two important means of attaining this goal.

Public Access Board -- The Public Access Board, under the Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles, uses a small portion of the income it receives from the state General Fund to acquire public access to great ponds and other waters and for access to snowmobiling, hiking, and skiing trails. The Board develops public sites by constructing launching ramps, canoe or small boat landings, parking areas, and approach roads.

The Public Access Board will continue to develop facilities throughout the state. The Board's program has been concentrated on the larger, more popular areas so that greater numbers of people will benefit.

The Public Access Board has acquired access to the following waters in the Central Region of Massachusetts:

<u>Water Body</u>	<u>Location</u>	<u>Area (acres)</u>
Merrimack		
Black Rock Creek	Salisbury	tidal waters
Flint Pond	Tyngsborough	61
Lake Attitash	Merrimac	360
Mascopic Lake	Tyngsborough	290
Merrimack River	Andover	14 miles of river
Nashua		
Baddacook Pond	Groton	76
Fort Pond	Lancaster	33
Knopps Pond	Groton	204
Squannacook River	Pepperell	river
Whalom Pond	Leominster	100
Blackstone		
Manchaug Pond	Sutton	412
Singletary Pond	Millbury	356
Wallum Lake	Douglas	256
SuAsCo		
Delaney Pond	Stow	168
Lake Chauncey	Westborough	185
Lake Quinsigamond	Shrewsbury	1051
Whitehall Reservoir	Westborough	601
Thames		
Alum Pond	Sturbridge	172
East Brimfield Reservoir	Brimfield, Sturbridge	420

5.10F Outstanding Wildlife Resources

Great Meadows National Wildlife Refuge -- Established in 1944, the Great Meadows National Wildlife Refuge preserves approximately 2,700 acres along the Concord and Sudbury Rivers. The refuge provides an outstanding area for waterfowl and other water-associated birds. Its headquarters is located in Concord, and the refuge extends into six surrounding towns.

Oxbow National Wildlife Refuge -- The Oxbow covers 662 acres, of Fort Devens in Harvard. The Defense Department transferred this area to the U.S. Fish and Wildlife Service in 1974. This area, listed as W-1 of the evaluated wetlands, lies along the Nashua River and provides an outstanding area for waterfowl.

Merrimack River Estuary -- This estuary, located in the town of Salisbury and Newburyport, is a bird watcher's hot spot. Waterfowl, shorebirds, songbirds, raptors, and other birds can be seen from the popular viewing spots along the estuary. During the 1974-75 winter a Ross' Gull, an exceedingly rare visitor from Siberia, was viewed by hundreds of people from all over the northeast who came specifically to see this bird.

Wildlife Management Areas and Sanctuaries -- The Massachusetts Division of Fisheries and Wildlife maintains over 20 wildlife management areas (WMA) and other holdings in the region. Three of the larger areas are the Pantry Brook WMA in Concord and Sudbury, Squannacook WMA in Townsend, Groton and Shirley and Bolton Flats WMA in Bolton. In addition approximately 2,000 acres of the U.S. Department of the Army's Fort Devens in the towns of Ayer, Shirley and Lancaster are managed as wildlife habitat by the Massachusetts Division of Fisheries and Wildlife.

The Massachusetts Audubon Society maintains four wildlife sanctuaries in the region. The largest of these sanctuaries is Wachusett Meadow in Princeton, which is adjacent to the Massachusetts Division of Fisheries and Wildlife's Minns Wildlife Sanctuary and Wachusett Mountain State Reservation owned by the Massachusetts Division of Forests and Parks.

Species Existing in Limited Numbers -- Table 5.25 lists wildlife species which exist in limited numbers in the Central Region. One's likelihood of observing any of these species is small, but their continued existence is important.

Several of the listed species are believed to be declining in numbers. One of these, the eastern bluebird, is believed to suffer from habitat decline, from the effects of pesticides, and from competition for nesting sites. Acid rain (a consequence of air pollution) is thought to be detrimental to the reproduction of the spotted, blue spotted, and marbled male salamander, and is a factor in their decline.

5.11 RECREATION

The analysis of recreation supply, demand, needs, and alternatives has been limited to those outdoor recreation activities which are water-related or which are normally assumed to be enhanced or complimented by adjacent water bodies. These activities include swimming, camping, picnicking, canoeing and sailing, and hiking. The primary data source for recreation has been the 1976 Statewide Comprehensive Outdoor Recreation Plan (SCORP) prepared by the Massachusetts Department of Environmental Management. Available recreation activities are shown in Table 5.26.

The available supply of recreation resources were obtained from figures for SCORP Regions III and IV, adjusted to fit the Central Region. The SCORP Regions are shown on Figure 5.14. The supply figures give a good indication of the extent of outdoor recreation available in the Central Region.

TABLE 5.25 Wildlife Species Existing in Limited Numbers in the State Which Are Found in the Central Region^{1/}

Species	Distribution	Estimated Numbers	Typical Habitat	Status ^{2/}
<u>Mammals</u>				
Eastern cougar	inconclusive, unverified reports from central and western Mass.	if present, cannot be more than a few	isolated mature or second growth woodlands and mountainous areas	endangered
Eastern coyote	Berkshire, Franklin, Hampden, Hampshire, and northern Worcester counties	probably several hundred	rural wilderness	
Moose	occasional stragglers range into northeastern, central, and western parts of the state	none resident; regular stragglers appear almost annually	wilderness areas of early successional mixed stands interspersed with bogs and shallow ponds	peripheral
<u>Birds</u>				
Eastern bluebird	transient statewide, limited breeding, especially in Conn. valley	unknown	open woods, swamps, rural roadsides, farmland, burnt-over areas	undetermined
<u>Reptiles</u>				
Blanding's turtle	northern Middlesex County and Haverhill (Essex County)	unknown	shallow, weedy ponds, slow moving streams	undetermined
Eastern box turtle	statewide, except mountainous regions	unknown	fields, woods, open woodlands, usually near water	undetermined
Black rat snake	south-central Mass., east to Webster, west to Westfield, north to Sunderland	unknown	wooded uplands, hillsides, forest edges	undetermined
Blue spotted salamander	recorded from various areas of Middlesex County and a few Essex County towns	unknown	lives underground in moist woodlands	threatened
Marbled salamander	principally throughout Worcester County and east (localized populations), with remnant colonies in Middlesex, Bristol, and Plymouth Counties	unknown	woodlands	threatened
Spotted salamander	localized populations statewide, except offshore islands	unknown	lives underground in moist woodlands	threatened
Four-toed salamander	scattered from Conn. valley eastward to Cape Cod	unknown	swamps, sphagnum bogs, acidic meadows	undetermined

1/ Augford, P.S. An Inventory of Massachusetts Fish and Wildlife (Vertebrate) Resources. Massachusetts Division of Fisheries and Wildlife, Boston, 1975.

2/ Rare - not immediately in peril and possibly stable at present, but existing in such low numbers or with such a restricted distribution that the entire species population could be seriously jeopardized by catastrophic events occurring within its range.

Endangered - in immediate danger of extinction or extirpation from the state due to critically low or drastically declining populations brought about by habitat modification, overexploitation, pollution, diseases, or other factors.

Status Undetermined - not in immediate danger of extinction or extirpation but showing signs of decline and causing justifiable concerns; or being little known or apparently uncommon and possibly could be jeopardized by inadvertent actions. More information required to properly evaluate status.

Peripheral - reaches the limit of its usual range outside Massachusetts. Occasional individuals or stragglers may be found but no breeding populations within the state.

Threatened - likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range.

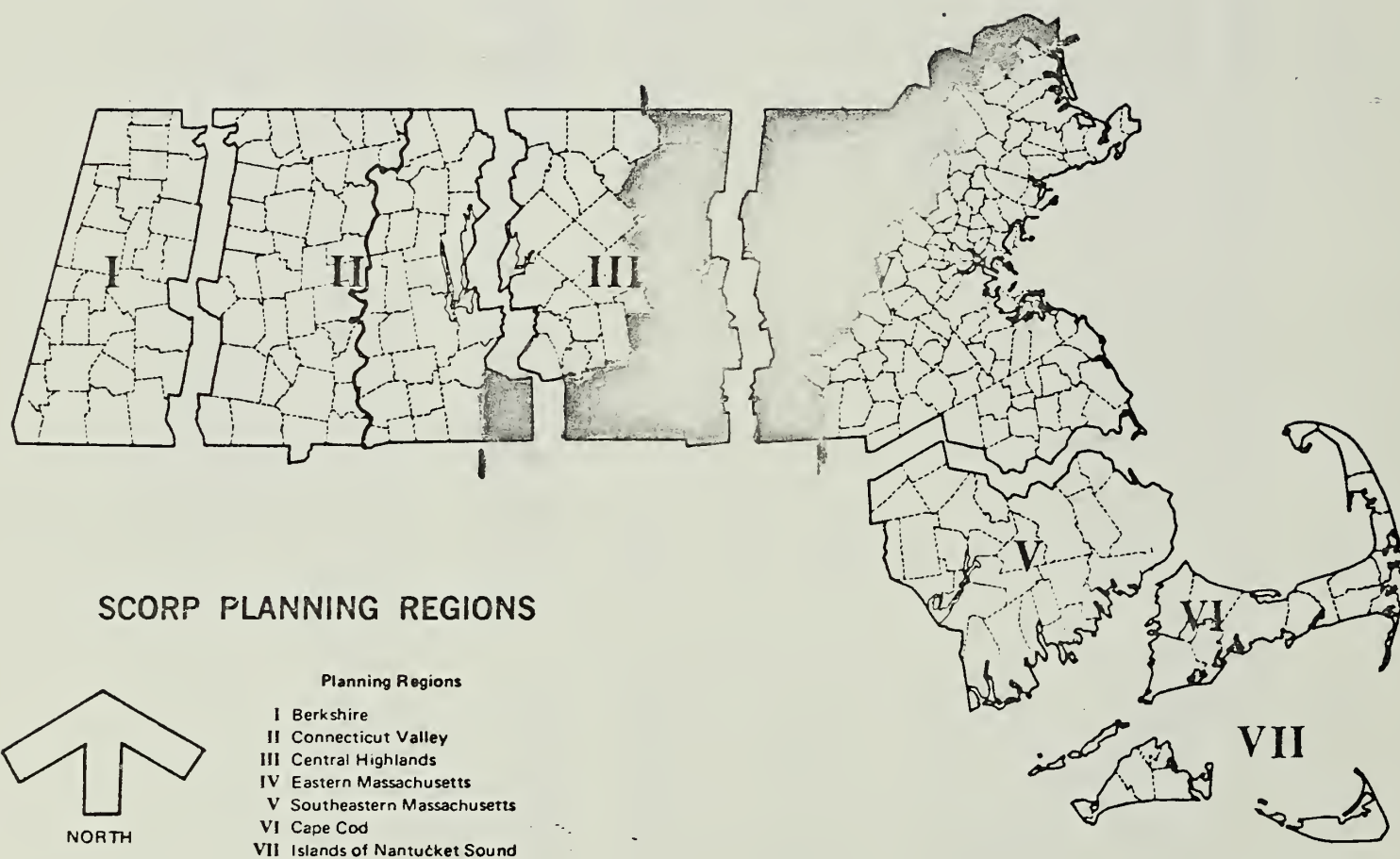


Figure 5.14



Towns in MWRS Central Region

TABLE 5.26 SUPPLY OF SELECTED RECREATION ACTIVITIES

<u>Activity</u>	<u>Supply (1000 Activity Days)</u>
Swimming	10,950
Camping	363
Picnicking	1,061
Canoeing-Sailing	1,943
Hiking	860

In addition to the recreation resources that can be quantified by the activity days that they provide, the Central Region boasts a number of "landscape and natural areas" which provide a large quantity of passive recreation and enjoyment. These areas which have been identified in the 1974 Massachusetts Landscape and Natural Areas Survey include natural areas with unique scenic, historic or scientific significance. There is a total of 55 of these natural areas located in the region. Of these, 32 sites are owned by governments, private conservation organizations, or institutions. Twenty-three of the natural areas are wholly or partially owned by private individuals. Ownership of the natural areas is quite important in determining public access to enjoy the resource. The vulnerability of the area to disruption, and even possible loss through development is also dependent upon ownership and owner attitude. In some cases, the publicly owned areas are in jeopardy while some privately owned areas are safe and zealously protected by the owner.

The region's historical and cultural attractions include the Minuteman National Historic Park in Concord and Old Sturbridge Village which duplicates an early 19th century rural New England village. Numerous historic inns, homes, mills, and other buildings are a reminder of the vivid history of the region. The region has approximately 70 properties listed in the National Register of Historic Places, of these, 13 have been designated as National Historic Landmarks. The many museums, colleges and universities add to the cultural base of the area.

The region's rivers represent a great, largely undeveloped recreational resource. There are over 1,380 miles of main rivers and tributaries in the region. Seven river reaches in the Central Region are identified in the SCORP report as providing excellent potential for development as canoe trails. The Nashua River Watershed Association sponsors an annual canoe race on the Nashua every spring and in addition has published a canoe guide for the Nashua River. Table 5.27 indicates the portions of river identified for this purpose.

TABLE 5.27 POTENTIAL CANOE TRAILS

<u>River</u>	<u>Section of River</u>
Stillwater River	Leominster to Wachusett Reservoir
Nashua River	Clinton to New Hampshire
Stony Brook	Littleton to Chelmsford
Merrimack River	Tyngsborough to Newburyport
Concord River (and Sudbury River)	Framingham to Lowell
Shawsheen River	Bedford to North Andover
Quinsigamond River (and Blackstone River)	Flint Pond, Grafton to Uxbridge

The SCORP report also identifies several rivers which should be considered for protection under the Scenic and Recreational Rivers Act, Chapter 21, Section 17B of the General Laws. These rivers are included in Table 5.28.

TABLE 5.28 POTENTIAL SCENIC AND RECREATIONAL RIVERS

<u>River</u>	<u>Section of River</u>
Nashua River	Leominster to New Hampshire
Nissitisset River	New Hampshire line to Nashua River
Squannacook River	Source to mouth
Quinapoxet River	Source to Wachusett Reservoir
Assabet River	Tyler Dam to Hudson Dam
Sudbury River	Hopkinton town line to Ashland Dam
Concord River	Confluence of Sudbury and Assabet Rivers to mouth
Shawsheen River	Billerica and Tewksbury
West River (Blackstone River)	West Upton Dam to mouth
Quinebaug River	East Brimfield Dam to Connecticut state line

There are 260 ponds and lakes, all measuring at least 20 acres in size, located within the region. These provide more than 30,000 acres of surface water. Surface water bodies are used for municipal and industrial water supply, fishing, fish and wildlife habitat, swimming, and boating, as well as providing visual contrast and aesthetic pleasure.

Access to freshwater bodies in the region is usually a function of their ownership and use. Reservoirs used for municipal water supply normally have restrictions upon public access and use. Swimming or wading is prohibited by state statute in all but supplementary, emergency supplies. Fishing and boating is also restricted, although there may be scattered instances of tightly-controlled reservoir fishing. Public access to the ponds, lakes, and reservoirs of the region is detailed in Appendix C prepared for the study by the Massachusetts Division of Water Resources.

The federal government provides numerous recreation opportunities throughout the region. The National Park service is in the process of acquiring an additional 80 acres of land before 1980 to add to the 500-acre Minuteman National Historic Park in Concord, Lexington, and Lincoln. The U.S. Fish and Wildlife Service manages two refuges in the region; the Great Meadows National Wildlife Refuge along the Sudbury and Concord Rivers and the Oxbow National Wildlife Refuge along the Nashua River within the Fort Devens U.S. Military Reservation.

The state government is the largest landholder of open space and recreation acreage in Massachusetts. The Division of Forests and Parks and the Division of Fisheries and Wildlife are the state agencies who administer most of the state's recreation acreage. Over a thousand acres of PL 83-566 project land owned by Massachusetts Water Resources Commission is open to passive recreation. Table 5.29 lists major public and quasi-public recreation use areas giving their location and size.

Town conservation land, town forests, and sometimes water supply watershed lands provide passive recreation close to population centers.

Table 5.29

Major Public and Quasi-Public Areas with Recreation Use

Agency	Site ^{1/}	Location	Size-Acre
<u>Federal</u>			
U.S. Army Corps of Engineers	West Hill Dam	Uxbridge	614 ^{2/}
	East Brimfield Lake	Sturbridge, Brimfield, Holland	2070
	Westville Lake	Southbridge	578 ^{2/}
	Buffumville Lake	Oxford	488
	Hodges Village Dam	Oxford	873
U.S. National Park Service	Minuteman National Historic Park	Concord, Lexington, Lincoln	508
U.S. Fish & Wild- life Service	Great Meadows Na- tional Wildlife Refuge	Bedford, Billerica, Carlisle, Concord, Lincoln, Sudbury, Wayland	2700
	Oxbow National Wildlife Refuge	Harvard	662
<u>State</u>			
Massachusetts Division of Forests & Parks	(1) Salisbury Beach S.R.	Salisbury	520
	(2) Wachuset Mt. S.R.	Princeton, Westminster	1696
	(3) Walden Pond County R.	Concord, Lincoln	350
	(4) Walden Pond S.P.	Concord, Lincoln	117
	(5) Ashland S.P.	Ashland	470
	(6) Cohituate S.P.	Framingham, Natick, Wayland	1126
	(7) Hopkinton S.P.	Ashland, Hopkinton	960
	(8) Warren Manning S.P.	Billerica	40
	(9) Whitehall S.P.	Hopkinton	877
	(10) Lake Quinsigamond S.P.	Shrewsbury, Worcester	39
	(11) Purgatory County R.	Sutton	300
	(12) Wells S.P.	Sturbridge	1081
	(13) Billerica S.F.	Billerica	335
	(14) Blanchard Road S.F.	Andover	35
	(15) Carlisle S.F.	Carlisle	58
	(16) Harold Parker S.F.	Andover, Boxford, Geroge- town, Middleton, North Andover, North Reading	3511
	(17) Lancaster S.F.	Lancaster	90
	(18) Lowell-Dracut S.F.	Lowell, Dracut	796

Table 5.29 cont.

Major Public and Quasi-Public Areas with Recreation Use

Agency	Site ^{1/}	Location	Size-Acre
Massachusetts Division of Forests & Parks (cont.)	(19) Marlborough S.F.	Marlborough	60
	(20) Sudbury S.F.	Hudson, Marlborough, Stow	234
	(21) Upton S.F.	Hopedale, Hopkinton, Northbridge, Upton	2,695
	(22) Ashby S.F.	Ashby	20
	(23) Douglas S.F.	Douglas	3,227
	(24) Leominster S.F.	Fitchburg, Leominster, Princeton, Sterling	2,953
	(25) Oxford S.F.	Oxford	29
	(26) Squannacook River S.F.	Townsend	299
	(27) Sutton S.F.	Sutton	624
	(28) Townsend S.F.	Townsend	3,092
	(29) Willard Brook S.F.	Ashby, Townsend, Lunenburg, Fitchburg	2,554
	(30) Westminster S.F.	Gardner, Westminster	1,406
	(31) Brimfield S.F.	Brimfield, Monson, Wales	3,289
Massachusetts Division of Fisheries and Wildlife	(1) Ayer Game Farm	Ayer	97
	(2) Merrill Pond System	Sutton	216
	(3) Pantry Brook W.M.A.	Concord, Sudbury	401
	(4) Townsend W.M.A.	Townsend	60
	(5) Westborough W.M.A.	Westborough, & Field Trail Area Northborough	333
	(6) Cosne Pond W.M.A., West Newbury	West Newbury	243
	(7) Northborough W.M.A.	Northborough	88
	(8) Squannacook W.M.A.	Townsend, Groton, Shirley	711
	(9) Charlton W.M.A.	Charlton	287
	(10) Nissitissit River W.M.A.	Pepperell	246
	(11) North Shore W.M.A., Salisbury portion	Salisbury	97
	(12) E. Kent Swift W.M.A.	Mendon, Northbridge, Uxbridge	157
	(13) Carr Island W.S.	Salisbury	110
	(14) Minns W.S.	Princeton	137
	(15) Ram Island W.S.	Salisbury	20
	(16) Flint Pond Access	Tyngsborough	82
	(17) Knops Pond Lot Access	Groton	<1
	(18) Mascopic Lake Access	Dracut	<1
	(19) Quinapoxet River. Area Access	Holden	32
	(20) Marcus Area Access	Uxbridge	28
	(21) Fort Devons W.M.A.	Ayer, Shirley, Lancaster	2,000 ^{2/}
	(22) Bolton Flats W.M.A.	Bolton	600

Table 5.29 cont.

Major Public and Quasi-Public Areas with Recreation Use

Agency	Site ^{1/}	Location	Size-Acre
Massachusetts Water Resources Commission	(1) Delaney Flood Control Project and W.M.A.	Harvard, Bolton, Stow	581
	(2) Tyler Flood Control Project	Northborough, Marl- borough	233
	(3) Ross Flood Control Project	Berlin	238
	(4) Brewer Brook Flood Control Project	Berlin	50
	(5) Nichols Flood Control Project	Westborough	520
	(6) Rawsen Hill Brook Flood Control Project	Shrewsbury	80
	(7) Hop Brook Flood Control Project	Northborough	160
	(8) Cold Harbor Flood Control Project	Northborough	206
	(9) Barefoot Brook Flood Control Project	Northborough, Marl- borough	54
Metropolitan District Commission	(1) Wachusetts Reser- voir Reservation	West Boylston Sterling Boylston Clinton	10,809
	(2) Sudbury Reservoir Reservation	Marlborough Southborough	3,214
Trustees of Reservations	(1) Charles Ward Reservation	Andover	375
	(2) Old Manse	Concord	8
	(3) Redemption Rock	Princeton	< 1
	(4) Tantiusques	Sturbridge	55
Massachusetts Audubon Society	(1) Waseeka W.S.	Hopkinton, Holliston	140
	(2) Lincoln Woods W.S.	Leominster	60
	(3) Wachusett Meadow W.S.	Princeton	907
	(4) Laurel Woods W.S.	Holden	16

^{1/} Following abbreviations are used:

S.R. - state reservation

S.P. - state park

S.F. - state forest

W.M.A. - wildlife management area

W.S. - wildlife sanctuary

^{2/} Managed by Massachusetts Division of Fisheries & Wildlife as wildlife habitat under agreement.

Private lands which are open to the public for passive enjoyment are also important in the region. The Massachusetts Audubon Society controls approximately 1,100 acres of land which is managed for wildlife habitat and which also provides hiking trails and opportunities to observe and enjoy the natural beauty of the areas. Also, the Trustees of Reservations are responsible for the management of approximately 450 acres of natural areas which are used extensively for passive recreation.

Recreation planning on a regional basis has been done by the regional planning agencies and by the Massachusetts Department of Environmental Management (DEM), Office of Planning. The 1976 SCORP was produced by DEM and a representative plan for the RPA work is "Regional Recreation and Open Space and the Urban Cultural Park" by the Northern Middlesex Area Commission. In addition, watershed associations and other private groups have made important contributions in recreation planning and later implementation; for example, the Nashua River Watershed Association's 'Greenway Project which is establishing a greenbelt in the Nashua River flood plain in Massachusetts and New Hampshire. Other greenbelt proposals have been presented by the RPA's and others for the Merrimack River and other major rivers in the region. Establishment of greenbelts for the Merrimack, Concord, Sudbury, Assabet, Blackstone, and Quinebaug Rivers, similar to the Nashua River program, is a worthwhile proposal which could greatly increase the recreation base of the region. With the improvement in water quality projected for these major rivers, their recreation value will increase.

A major state recreation project is now underway in the Lowell area. This project is on a par with the other five major state projects, one of which is the Boston Harbor Islands project. The Lowell Heritage State Park funded at approximately \$9 million is focused on the Merrimack and Concord Rivers and the interconnecting industrial canal system on which the textile industry in Lowell depended. In addition to the state's and the city of Lowell's efforts, the U.S. Congress is considering a bill to establish a Lowell National Cultural Park to be administered by the National Park Service. The report from the Lowell Historic Canal District Commission provides the background for this congressional bill. The estimated cost of this congressional plan is approximately \$40 million.

Two other canal systems, both long abandoned, have been proposed for restoration for recreational purposes. They are the Middlesex Canal which went from Boston Harbor to the Merrimack River at Lowell, and the Blackstone River Canal which originated in Rhode Island and terminated in Worcester. A few of the larger water bodies in the Blackstone Watershed were impounded by the builders of the Blackstone Canal to augment summer low flows in this canal.

There are numerous opportunities for hiking in the region. Massachusetts Division of Forests and Parks have developed hiking trails in the state forests, parks, and reservations and there are extensive short distance trails which have been developed by members of the Appalachian Mountain Club and other similarly orientated groups. The 1976 SCORP mentions the mid-state trail, which runs from Douglas on the Rhode Island state line to Ashburnham which borders New Hampshire. This trail connects with the Wapack trail which continues on to Pack Monadnock Mountain in New Hampshire.

5.12 EXISTING PROGRAMS

Information on programs which effect the resources we are addressing in this study is summarized in the following tables and figures.

TABLE 5.30

EXISTING PROGRAMS

Subject	Agency	Law or Program
Lard Use	Municipalities	Massachusetts General Laws, Chapter 61A, Sections 1-24 - The Agricultural and Horticultural Assessment Act. The act is designed to provide economic incentives in the form of lower property taxes to encourage maintenance of productive agricultural or horticultural pursuits. The act also has the effect of preserving open space. Massachusetts is one of 32 states that provide for such assessments. This act is sometimes referred to as the "Current Use Taxation of Farmland and Horticultural Land."
	Municipalities.	Massachusetts General Laws, Chapter 184, Sections 23-33 - An act to protect conservation and preservation restrictions which are held by an appropriate public authority.
	Municipalities, Mass. Division of Forests and Parks	Massachusetts General Laws, Chapter 61, Sections 1-7 - The Classification and Taxation of Forestlands (General Laws, Chapter 61) as amended. Landowners who have at least 10 contiguous acres of forestland having a value not over \$400 an acre (land and timber) may apply to their local tax assessors to have their forestland classified under the law. If the state forester determines that the woodland owner qualifies, the land and timber are taxed separately. The land is assessed at not more than \$10 per acre and annual taxes are paid on this basis. Also, a forest products tax of 8 percent is paid on the value of forest products harvested. A rollback applies if the land is withdrawn from the forest classification. In addition to the tax incentive program for private landowners there is a forest management program for public forest holdings.
	Soil Conservation Service, Conservation District, landowners	Conservation Operations Program - Proper land treatment is the basic concern of the Soil Conservation Service. This is the purpose of the Conservation Operations Program which provides technical assistance and advice on soil and water conservation to land users through local conservation districts. In the region, requests for assistance go to the Essex, Middlesex, Northeastern Worcester, Northwestern Worcester, Southern Worcester or Hampden Conservation Districts which determine priorities for the Conservation Operations Program. The district is an arm of state government, having five unpaid supervisors whose job it is to consult with and advise the local SCS staff in scheduling their work load.
		Practices applied in the Conservation Operations Program include improved agronomic practices, measures to reduce soil erosion, practices designed to help carry water safely off sloping land, drainage improvements, and comprehensive measures to improve wildlife habitat and recreational areas.
	Farmers Home Administration, landowners	Soil and Water Loans - These loans are to facilitate improvement, protection, and proper use of farmland by providing adequate financing and supervisory assistance for soil conservation; water development, conservation and use; forestation; drainage of farmland; the establishment and improvement of permanent pasture; and related measure. Loans cannot exceed \$100,000.
	U.S. Agricultural Stabilization and Conservation Service, landowners	The Agricultural Conservation Program (ACP), provides cost sharing assistance to farmers and other landowners who undertake soil, water, forest and wildlife conservation practices. The cost for such practices is shared between the federal government and the landowner. Technical assistance for ACP practices is rendered by the Soil Conservation Service, the Extension Service, and the U.S. Forest Service in cooperation with the Massachusetts Division of Forests and Parks.

COMMUNITIES WITH LAND ASSESSED UNDER G.L. CH. 61A -
THE AGRICULTURAL AND HORTICULTURAL REASSESSMENT ACT

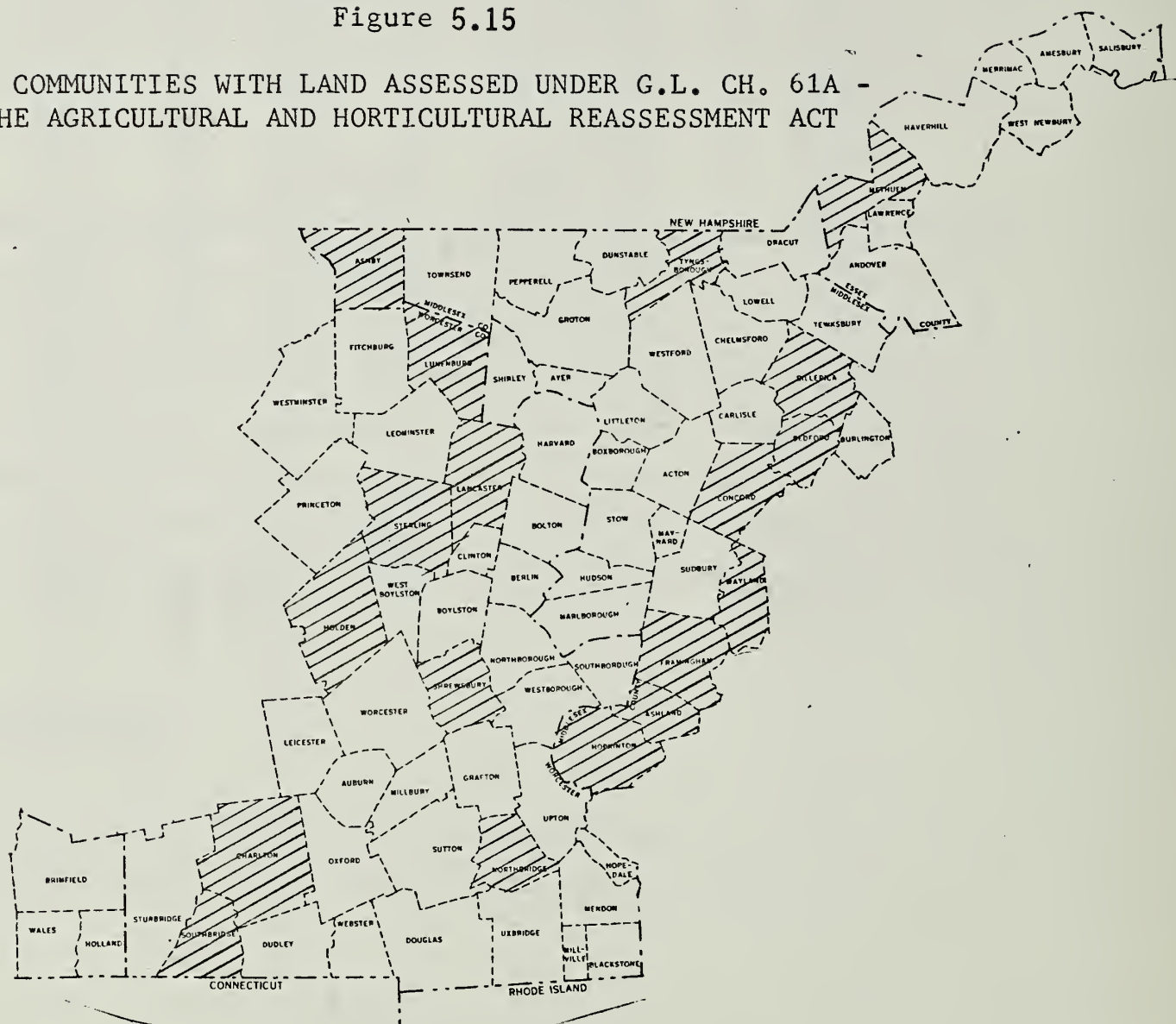


TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use	Municipalities	Zoning Enabling Act, Mass. General Laws Chapter 40A - The Act contains the basic authority for municipal zoning, predicated on the traditional police power concept of the promotion of health, safety, morals and general welfare. The Act authorizes municipalities to enact zoning laws designed among other purposes to lessen congestion in the streets, to conserve health; to secure safety from fire, panic and other dangers; provide adequate light and air; to prevent overcrowding of land; to avoid undue concentration of population; to facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirements; to conserve the value of land and buildings; to encourage the most appropriate use of land throughout the city or town; and to preserve and increase its amenities.
		Zoning may regulate and restrict the height, number of stories, and size of buildings and structures, the size of width of lots, the percentage of lot that may be occupied, the size of yards, courts and other open spaces, the density of population, and the location and use of buildings, structures and land for trade, industry, agriculture, residence or other purposes.
	Municipalities	Earth Removal-Mass. General Laws Chapter 40, Section 21 (17) and Chapter 40A, Section 2 - Municipal regulation of the extraction of removal of soil, sand, gravel, and other minerals was first carried on under the Zoning Enabling Act, which specifically authorizes municipalities to "regulate and restrict the...use of land...and (to) prohibit noxious trades within the municipality or any specified part thereof." The state legislature further empowered municipalities to enact nonzoning bylaws "prohibiting or regulating the removal of soil, loam, sand or gravel from land." In addition to exempting public land, the nonzoning bylaw must exempt earth removal which is part of site preparation for an approved subdivision or which is "the subject of a permit or license issued under the authority of the town." Because of these limitations, communities may and often do use both types of bylaws to ensure adequate coverage.
Municipalities	Municipalities	Typically, such bylaws require a permit for earth removal and impose certain conditions upon the operation as a prerequisite to obtaining such a permit. Conditions may include, for example, control of drainage, maintenance of buffer zones along wetlands or public ways, screening and fencing, measures to reduce dust, limitation of the hours of operation; and grading, regrading, reseedling and reseeding after the work is done. Some eight municipalities have passed bylaws entirely prohibiting earth removal activities, except those absolutely necessary for preparation of a building site.
		Agricultural Preservation - Chapter 232 of the Acts of 1977 authorizes cities and towns to appropriate money for the purchase of development rights on farmlands.
Municipalities & Mass. Dept. of Agriculture		Agricultural Preservation - Chapter 780 of the Acts of 1977 provides for the acquisition of agriculture preservation restrictions by the Commonwealth.

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service, municipalities	<p>Soil Survey - The SCS has the federal leadership for conducting the National Cooperative Soil Survey. In Massachusetts, the soil survey is carried on cooperatively with the Massachusetts Agricultural Experiment Station. Soil survey activities include the mapping, classification, correlation, and interpretation of soils according to national standards. The surveys are a basic scientific inventory of soil resources, based on soil properties. These surveys identify the kinds of soils, their extent, location and characteristics.</p> <p>Soil surveys play a vital part in planning by:</p> <ol style="list-style-type: none"> 1. Providing a permanent inventory of the soil resources, 2. providing soil interpretations for various uses to guide planners at the local, regional, and state levels in making sound land use decisions for developing comprehensive plans, 3. providing data on the location of: <ol style="list-style-type: none"> a. wetlands, steep land, rocky land and areas with a high water table b. areas suitable for waste disposal c. areas that are suitable for use as residential, commercial, industrial, or school sites 4. providing many other soil interpretations that contribute to planning for a better quality environment. <p>Many communities need, and want, soil survey information before the report is published in the usual manner. To provide this information ahead of the published report time, the SCS in Massachusetts prepares special soils reports for those communities which help pay for cost of preparation.</p> <p>A town soils report consists of a narrative description of each soil found within the community, copies of the soil survey mapping sheets and interpretative maps. These interpretative maps show the limitations of the soils for selected uses, such as sewage disposal, home sites or industrial sites. See Figure 5.16 for the status of the soil survey in the region.</p> <p>Resource Conservation and Development Areas - Resource Conservation and Development (RC&D) Areas are locally initiated, sponsored and directed programs which are planned to accelerate the conservation and development of natural resources; improve the general level of economic activity; and enhance the environment and standards of living. Each RC&D plan has its own unique goals. RC&D areas are sponsored by Conservation Districts, towns and county governments, and may include municipalities, state agencies, comprehensive planning agencies and local nonprofit organizations. In Massachusetts two RC&D areas have been established: The Berkshire-Franklin RC&D Area in Berkshire and Franklin Counties and the Pilgrim RC&D Area in Barnstable, Bristol, Dukes, Nantucket, and Plymouth Counties.</p>
	U.S. Soil Conservation Service, other USDA agencies, municipalities Conservation Districts	

STATUS OF SPECIAL SOILS REPORTS FOR COMMUNITIES

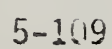


TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program						
Land Use cont.	U.S. Soil Conservation Service, Extension Service, Mass. Division of Forests and Parks, Mass. Division of Fisheries and Wildlife, Conservation Districts, municipalities	<p>Natural Resources Planning Program - The NRPP provides for local communities to inventory their present natural resources, to rate those resources against standards and criteria, to determine the consequences of proposed actions on natural resource base, and to plan the most acceptable future course of action to maintain or improve the community's level of environmental quality.</p> <p>The Natural Resources Planning Program:</p> <ol style="list-style-type: none"> 1. Gives citizens the major role, with local people doing most of the work, making all the decisions, and implementing any needed changes in community policies to meet their goals, 2. closely relates the community's natural resources base to numbers of people the natural resources can safely support, 3. provides help from regional technical teams that represent many agencies and disciplines. The teams are composed of personnel from the Soil Conservation Service, Cooperative Extension Service, Massachusetts Division of Fisheries and Wildlife, and Massachusetts Division of Forests and Parks. Other state and federal agencies assist as requested. The Conservation District accepts applications from communities requesting the program, screens the applications, establishes priorities for assistance by the technical teams, and coordinates agency assistance to the selected communities, 4. includes standards and criteria for rating the resource base, 5. is "open ended": Local citizens can continually monitor their area's natural resource condition and update land use plans as needed. <p>One of the most important aspects of the program is its emphasis on citizen involvement. Local citizens provide the personnel to: (1) inventory, in detail, the present natural resources of their community (2) rate these natural resources against existing standards and criteria (3) identify problem areas (4) assess alternative courses of action (5) prepare a definite plan of action and then, (6) implement planned measures to maintain or enhance their natural resources to achieve the community's selected level of environmental quality. Whatever course of action a community chooses, through use of the program, the community will know in advance the likely consequences of those actions on the natural resource base.</p> <p>The following have started work under this program:</p> <table> <tr> <td>Acton</td><td>Methuen</td><td>Sudbury</td></tr> <tr> <td>Chelmsford</td><td>Sterling</td><td>Westminster</td></tr> </table> <p>Resource Conservation and Development Loans - These loans are to assist sponsoring public agencies in Resource Conservation and Development (RC&D) Areas. Loan funds may be used for (1) rural community public outdoor-oriented water-based recreational facilities; (2) soil and water, development, conservation control and use facilities; (3) community water storage facilities. Loans cannot exceed \$250,000.</p>	Acton	Methuen	Sudbury	Chelmsford	Sterling	Westminster
Acton	Methuen	Sudbury						
Chelmsford	Sterling	Westminster						
	Farmers Home Administration, RC&D sponsors							

Figure 5.17

COMMUNITIES PARTICIPATING IN THE
NATURAL RESOURCE PLANNING PROGRAM (NRPP)

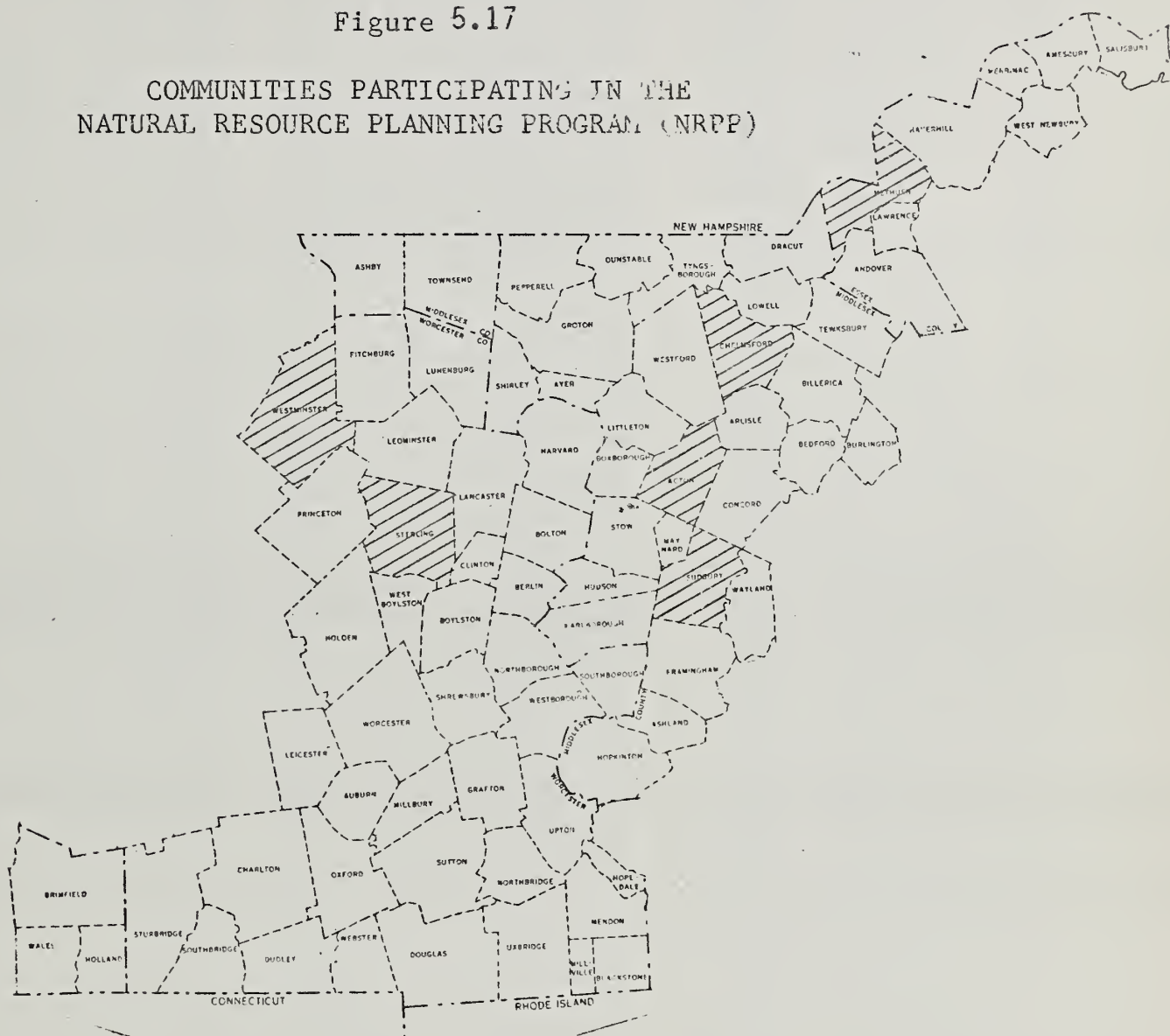


TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service Extension Service, Mass. Natural Resources agencies	<p>Natural Resource Inventories - These studies identify and describe areas with natural resource development potential within the community. Each area is described and its alternative development potentials are listed in a report. Opportunities and problems in the use of each site or areas are identified and discussed.</p> <p>The Soil Conservation Service, County Regional Extension Service, Massachusetts Division of Forests and Parks, Massachusetts Division of Fisheries and Wildlife and other agencies conduct natural resource inventories for communities. A community wishing a natural resource inventory requests help from the Conservation District which, in turn, arranges for the inventory.</p> <p>Status of the Natural Resources Inventory Program is shown on Figure 5.17.</p>
Land Use Forest- land	U.S. Forest Service, Mass. Division of Forests and Parks, landowners	<p>Renewable Resources Program - The Forest Resources Planning Act of 1974 provides for long-term planning for the management, protection and utilization of all renewable resources on forestland. The Forest Service and the Massachusetts Department of Environmental Management, Division of Forests and Parks, cooperatively conduct forestry programs on state and privately owned forestland. The forest resources of the Central Region also benefit from research in various aspects of forestry conducted at 80 different laboratories and other scientific facilities. These activities are grouped into five systems: recreation, wildlife, timberland and water, human and community development.</p> <p>Recreation System - The goal of this system is to increase the supply of outdoor recreation opportunities and services through programs which emphasize dispersed recreation. Assistance is given private forest landowners who are interested in helping provide public recreation opportunities, or integrate multiple uses into their forest management programs.</p> <p>Research is conducted to strengthen technology and understanding of recreation demands, trends, values and environmental impacts, as well as quantify and rank commodity and amenity values.</p> <p>Wildlife System - This system provides for increased use and enjoyment of wildlife while increasing both the diversity and numbers of fauna and the protection of threatened and endangered species. Technical assistance and financial incentives encourage nonindustrial private forest landowners to include habitat protection and development among their own management objectives.</p> <p>Research emphasizes habitat identification and improvement for endangered species and the impact of alternative forest practices on game and nongame habitats and populations.</p> <p>Timber System - The goal for the timber system is to increase timber supplies and quality to the point where benefits are commensurate with costs. Opportunities to increase timber supply exist on small private holdings, as well as, on Massachusetts state-owned forest areas. The program provides incentives for private timber landowners to grow commercial timber and for improved use of the trees and logs that are harvested.</p> <p>Major research includes better utilization of timber; improving the rates of timber growth and yield, improving the protection for forests from wild fire, insects and diseases; and providing better inventory and evaluation of resources.</p>

TABLE 5.30

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use Forest- land cont.	U.S. Forest Service, Mass. Division of Forests and Parks, landowners cont.	<p>Land and Water System - The land and water system is an aggregation of many basic stewardship and land treatment activities to meet minimum air and water quality standards. This system permits control of man-caused erosion on state and private forestlands through technical assistance and program support.</p> <p>Important areas of research include the nature and extent of nonpoint sources of pollution, improved logging practices for fragile soils and steep slopes, and improved efficiency of fire prevention and firefighting operations.</p> <p>Human and Community Development System - This system is concerned with the relationships between man and his forest environment. All renewable resource programs are focused to increase goods and services from forestland; this means serving employment, housing and other social needs.</p> <p>Assistance to communities is provided for urban and community forestry, rural community fire protection and land use planning. Conservation education and manpower training programs are designed to enhance the knowledge and skills of rural residents.</p> <p>The Massachusetts Department of Environmental Management and the Massachusetts Department of Fisheries, Wildlife and Recreational Vehicles are applying multiple-use management to approximately 35,000 acres of forestland under their jurisdiction as authorized under General Law 132, Section 31, and General Law 131, Section 6.</p> <p>The Forest Incentives Program (FIP) provides cost-sharing assistance to landowners who undertake forestry conservation practices. Program objectives are to increase the production of timber and wood products to reduce and abate pollution of streams and other bodies of water by planting trees in disturbed areas and to benefit communities by providing wildlife and landscape beauty and increasing outdoor recreation opportunities. The cost for such practices is shared between the federal government and the landowner. Technical assistance is provided by the SCS and the Forest Service in cooperation with the Massachusetts Division of Forests and Parks.</p>
Flooding	U.S. Soil Conservation Service, state and local governments, U.S. Forest Service	<p>Public Law 83-566, The Small Watershed Protection and Flood Prevention Program - PL-566 provides federal technical, and financial assistance to states, local communities, conservation districts, and other groups in solving their land and water problems.</p> <p>Project purposes which may be included in a PL-566 watershed plan include: conservation land treatment, flood prevention, agricultural water management, industrial and municipal water supply, recreation and fish and wildlife. Flood prevention must be a major concern in each project. PL-566 watersheds are limited to 250,000 acres in size. The program applies to land and water resource problems which cannot be solved by individual landowners on their own property.</p> <p>The PL-566 watershed program helps improve the quality of the natural resource base, the quality of the environment and the quality of the standard of living by:</p> <ol style="list-style-type: none"> 1. reducing erosion and sedimentation through the application of land treatment practices, 2. identifying flood hazard areas for flood plain management measures, 3. promoting proper land use and management, 4. improving agricultural water management practices, 5. providing multiple purpose reservoirs for recreation, fish and wildlife, and water supply, 6. reducing flood damages, hazards to life and health, and the inconvenience caused by flooding.

Figure 5.18

PL-566 WATERSHEDS

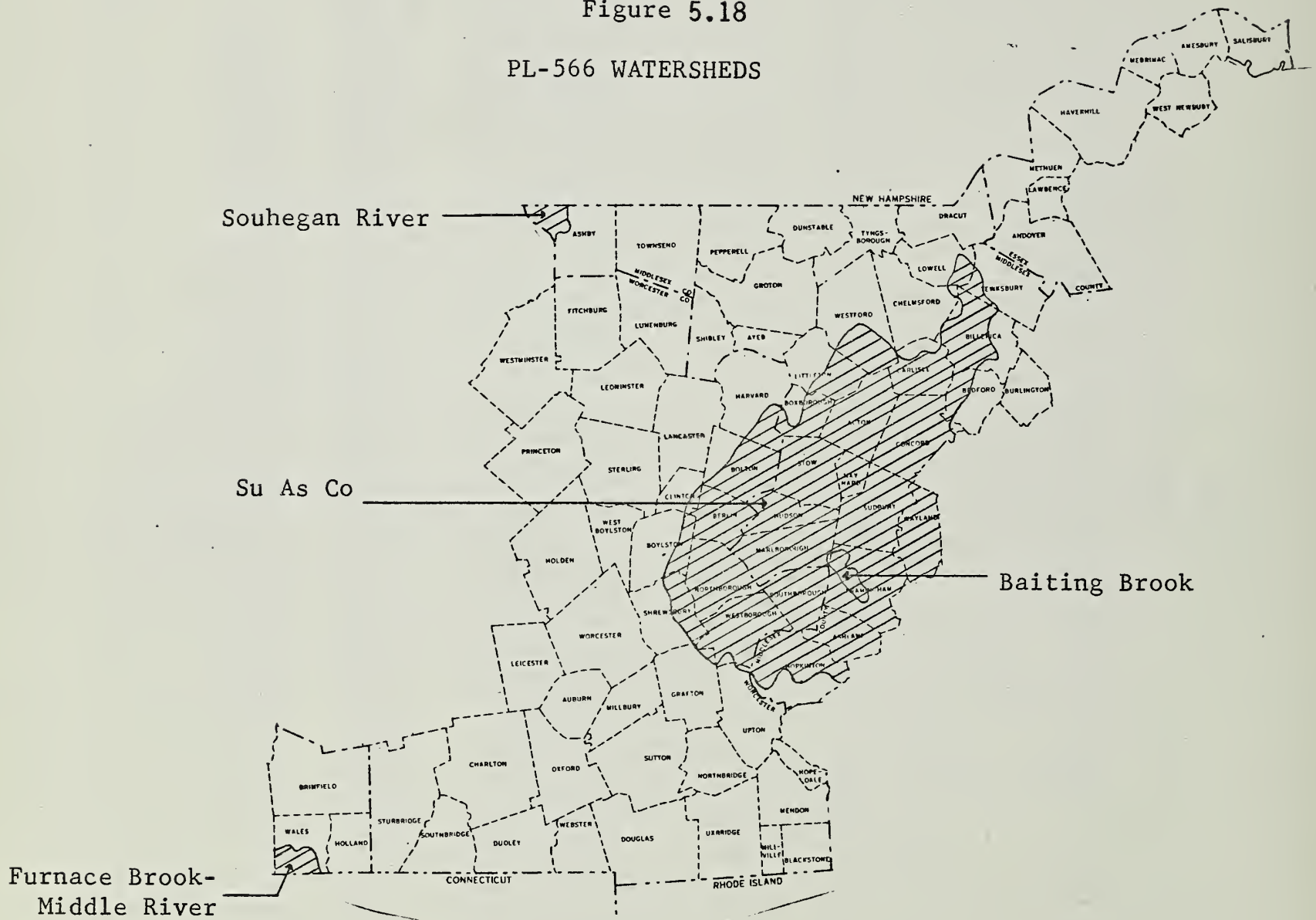


TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Flooding cont.	U.S. Soil Conservation Service, state and local governments, U.S. Forest Service cont.	<p>In the Central Region four watersheds are, or have been, involved in the PL-566 program. See Figure 5.18 for location of these watersheds.</p> <p>The Baiting Brook Watershed Project in Framingham, Massachusetts was approved for installation in 1957. Primarily because of land rights problems, the planned structural measures were not implemented. A revised watershed plan is nearing completion that responds to changes that have since taken place. Measures include land treatment, a floodwater retarding structure, channel work, and culvert modifications. The project will reduce average annual floodwater damages to residences, roads and bridges, and commercial establishments an estimated 84 percent. Sponsors of the project are the town of Framingham and the Middlesex Conservation District.</p> <p>The SuAsCo (Sudbury, Assabet and Concord Rivers) Watershed Project in Middlesex and Worcester Counties, Massachusetts was authorized for installation in 1959. Installation of project measures is nearly complete in this 241,617 acre watershed with the last of the nine structures under construction. The Nashoba Recreation Development mentioned in the planning documents will not be constructed. The project provides recreation and fish and wildlife benefits and flood protection for residences, commercial and manufacturing establishments, utilities, roads, and bridges. Project sponsors include: Northeastern Worcester County and Middlesex Conservation Districts, Massachusetts Department of Environmental Management, Massachusetts Division of Fisheries and Wildlife, and the Massachusetts Water Resources Commission.</p> <p>In addition two other authorized watershed projects are partially within the region. Both of these projects are mainly in adjacent states. The Souhegan River project is in Middlesex County, Massachusetts and Hillsborough County, New Hampshire with the other project, Furnace Brook, is in Hampden County, Massachusetts and Lolland County, Connecticut. Only land treatment measures were planned for the Massachusetts portion of these projects.</p>
Farmers Home Administration, PL-566, local sponsors		<p>Watershed Protection and Flood Prevention Loans - These loans provide assistance to local PL-566 sponsors to provide the local cost of improvements for flood prevention, irrigation, drainage, water quality management, sedimentation control, fish and wildlife development, public water-based recreation, and water storage and related costs. Applicants must have authority under state law to obtain, give security for and raise revenue to repay the loan and operate and maintain the facilities to be financed. The total amount of loans outstanding in any one watershed is limited to \$5,000,000.</p>
U.S. Department of HUD and municipalities		<p>National Flood Insurance Program - As of July 1977 all but three towns in the region had joined the National Flood Insurance Program, and property owners can now purchase low cost flood insurance protection. In return for this federally-subsidized insurance, the towns are required to consider flood hazards before issuing building permits, subdivision approvals, or zoning variances. After detailed hydrologic and hydraulic studies are made, HUD will issue flood zone maps which accurately delineate the flood hazard area and depth of flooding. Local governments must then require all new construction be above the 100-year flood elevation. Most financial institutions must require that flood insurance be purchased on any property within the flood hazard zone in which mortgages are accepted. As a condition of participation in the National Flood Insurance Program, a community must adopt flood plain management regulations meeting minimum standards published by the Federal Insurance Administration.</p>

COMMUNITIES PARTICIPATING IN THE NATIONAL FLOOD INSURANCE PROGRAM

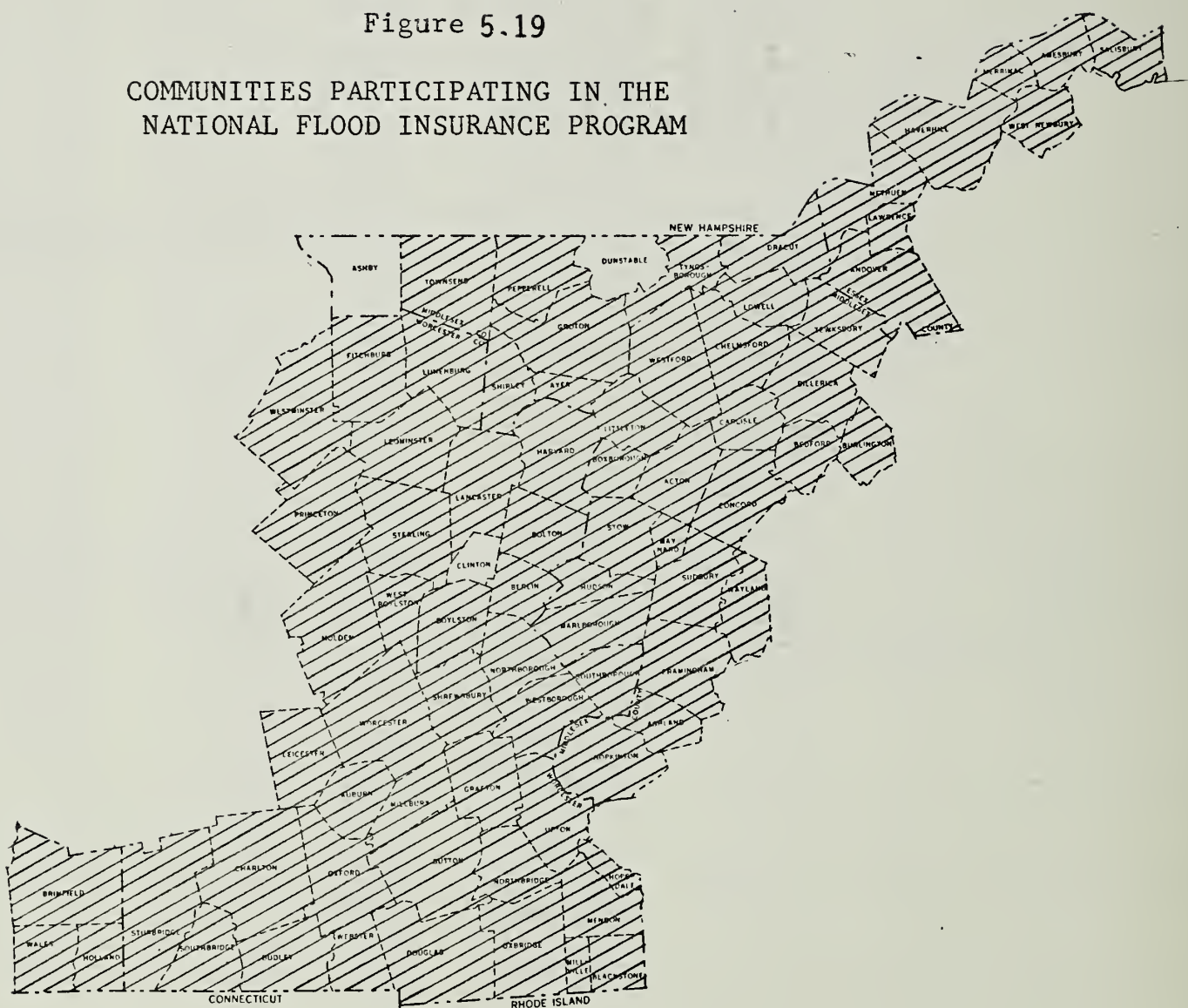


TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Flooding and Sediment	U.S. Department of HUD and municipalities cont.	A community must: (1) require building permits for all new construction and substantial improvements and (2) review the permit to assure that sites are reasonable free from flooding. For its flood prone areas the community must also require: (1) proper anchoring of structures, (2) the use of construction materials and methods that will minimize flood damage, (3) adequate drainage for new subdivisions, and (4) that new or replacement utility systems be located and designed to preclude flood loss.
	Mass. Department of Environmental Management, municipalities	Massachusetts General Laws, Chapter 780 Acts of 1977, the acquisition of Agricultural Preservation Restrictions is seen as a means of flood plain management by the State Department of Agriculture.
		Massachusetts General Laws, Chapter 131, Section 40A - The Inland Wetlands Restriction Act allows the Commissioner of Environmental Management, with the approval of the Board of Environmental Management, for the purpose of promoting the public safety, health and welfare, and protecting public and private property, wildlife, fisheries, water resources, flood plain areas and agriculture, can adopt, amend or repeal orders regulating, restricting, or prohibiting dredging filling, removing, or otherwise altering or polluting inland wetlands, or set encroachment lines on flood prone areas.
Erosion and Sediment	U.S. Soil Conservation Service, Districts, Landowners	Conservation Operations Program - Landowners and communities are assisted in their efforts to control erosion and sediment and in other conservation efforts by the Conservation Districts. The districts coordinate assistance from the Soil Conservation Service, the Extension Service, the Massachusetts Division of Forests and Parks in cooperation with the U.S. Forest Service for forestlands, and from other state and federal agencies.
Wetlands	Mass. Department of Environmental Management, Department of Environmental Quality Engineering	Massachusetts General Laws, Chapter 131, Section 40 - The "Hatch Act" passed by the Massachusetts General Court in 1965, attempted to control the alteration of the wetlands. This act has been modified several times by the General Court. The comparable legislation in force today is Chapter 131, Section 40, of the General Laws as amended by Chapter 818 of the Acts of 1974 and Chapter 363 and 334 of the Acts of 1975. This act controls, but does not ban development on wetlands. The law requires that any person or governmental agency intending to remove, fill, dredge, or alter a wetland must insure, by following various procedural and technical steps, that the activity will have no adverse effect on water supplies, flood prevention, pollution prevention, or fisheries protection. In effect the act requires an owner desiring to develop his wetlands do so in accord with public interest and safety.
		Chapter 131, Section 40, now called the Wetlands Protection Act is administered by town or city conservation commissions or the city mayor or town selectmen in communities without conservation commissions. Appeals from local decisions go first to the Massachusetts Department of Environmental Quality Engineering and, if unresolved at that level the courts become the final arbitrators.
	Mass. Department of Environmental Management, municipalities	Massachusetts General Laws, Chapter 131, Section 40A - The Inland Wetlands Restriction Act (see above write-up under Subject - Flooding).
		Massachusetts General Laws, Chapter 130, Section 105 - A program similar to the Inland Wetlands Restriction Act is available to protect saltwater wetlands. Progress in implementing the saltwater wetlands restriction program has been more dramatic than the inland restriction program. About 2,400 acres of saltwater wetlands in the town of Salisbury have deed restrictions files. This acreage constitutes most of the saltwater wetlands of the region.

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Wetlands cont.	Mass. Division of Fisheries and Wildlife, Mass. Division of Forests and Parks Municipalities	<p>Massachusetts state agencies, in particular, the Division of Forests and Parks and the Division of Fisheries and Wildlife have active land acquisition programs. In addition, the Division of Fisheries and Wildlife has given emphasis to wetlands acquisition to permanently protect wetlands having primary significance to fish and wildlife.</p> <p>Many communities in the region have embarked on conservation area plans which attempt to preserve and enhance the natural resources, and especially the water resources, within the community. Usually this effort is spearheaded by city or town conservation commissions which are authorized to prepare conservation and outdoor recreation plans, acquire open space, land and water areas, prepare and maintain open space areas, and advise local officials on matters relating to conservation subjects.</p> <p>Federal and state cost sharing funds are available to the cities and towns for use in purchasing conservation, open space and recreation areas. The Division of Conservation Services administers the Massachusetts Self-Help Act (General Law, Chapter 40, Section 8C) and administers or coordinates the Land and Water Conservation Program of the Bureau of Outdoor Recreation (U.S. Department of the Interior) within Massachusetts.</p> <p>In addition to acquisition programs, communities can adopt flood plain zoning ordinances to regulate the use of their wetlands and flood prone area. Restrictions imposed by the National Flood Insurance Program also tend to restrict wetland flood plain development. See the Flooding Section for more details on the National Flood Insurance Program.</p> <p>The Massachusetts Audubon Society, Trustees of Reservations and other similar organizations assist individuals and municipalities in protecting the region's wetlands and other natural resources. These groups engage in various activities including environmental education; acquisition of wetlands, flood plain and other important natural resource areas; wildlife sanctuary and reservation management; and assistance to the region's cities and towns in their respective wetland and other resource programs.</p>
Water Quality	Environmental Protection Agency, Mass. Division of Pollution Control, Mass. Division of Environmental Health, municipal- ities, industries	<p>Restoration and maintenance of water quality has been the result of a combined effort by the federal, state, and local governments; and private industry. The primary federal agency concerned with water quality is the Environmental Protection Agency. The Massachusetts Department of Environmental Quality Engineering is the lead state agency. Important divisions include the Division of Water Pollution Control and the Division of Environmental Health.</p>

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Water Supply	U.S. Dept. of Commerce municipalities	<p>Grants and Loans for Public Works and Development Facilities - This program provides grants of up to 50 percent of the development cost for such public facilities as water and sewer systems, and flood control projects. Jurisdictions designated as redevelopment areas may qualify for grants and loans. These areas may be counties, labor areas, or larger cities characterized by high unemployment or low family income. Severely depressed areas that cannot match federal funds may receive supplementary grants to bring the federal contribution up to 80 percent of the project cost.</p> <p>Loans are also available for public works and development facility projects. These loans may pay the full cost of a project and may run for as long as 40 years, the interest being determined by government borrowing costs. A community that is unable to raise its share of the eligible project cost may receive a grant for 50 percent or more of the project and a federal loan for the remainder of the cost.</p> <p>Water Favorability Studies - Under General Laws Chapter 21, Section 9, this program provides for studies of water favorability in areas of the Commonwealth where there may be a need for such a determination.</p> <p>Upon application of a county, conservation district or upon joint application by two or more municipalities, fire districts or water districts or regional district planning commissions, the Water Resources Commission may contract with any agency of the United States or with private firms to conduct water favorability studies within the jurisdictions indicated in the application. The applicants must provide one-half of the nonfederal cost, and special funding must be provided by legislation for the remainder.</p> <p>Massachusetts General Laws Chapter 767 Acts of 1970, authorizes the Water Resources Commission to acquire water impoundment sites to meet the future water resource needs of the Commonwealth.</p>
	Mass. Water Resources Commission, municipalities, other units of government	<p>Massachusetts Conservation "Self-Help" Act (G.L. Chapter 132A, Section 11 as amended) - The Massachusetts "Self-Help" Program makes funds available to communities for acquiring conservation-recreation lands. Improvements on land acquired with the help of the Self-Help Program, may include such things as informal playfields, trails, access roads, comfort stations, <u>water impoundments</u>, or <u>wells</u> and campsites.</p> <p>Reimbursements are available only to those municipalities which have established conservation commissions by accepting the provisions of Chapter 40, Section 8C of the General Laws. In addition, a Natural Resource Open Space-Recreation Plan must be filed with the Division of Conservation Services. The land must be controlled by the Conservation Commission after purchase by the community and accessible to any resident of the Commonwealth.</p> <p>An approved project may receive up to 50 percent of the cost of acquisition. If the community is also receiving federal funding assistance under a federal program, the addition of Self-Help funds may involve reimbursement of up to 75 percent of the total cost of the project.</p>
	Environmental Protection Agency, municipalities	<p>Drinking Water Supply-Technical Assistance - Under provisions of the Public Health Service Act (Pl. 93-523, as amended) the Environmental Protection Agency assists state and local water supply regulatory agencies and public water supply regulatory agencies and public water supply operators and officials to assure that water supply systems serving the public meet minimum National standards for the protection of public health.</p>

TABLE 5.30 - cont.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Water Supply	Farmers Home Administration, municipalities	Water and Waste Disposal Systems for Rural Communities - These loans and grants may be used for the installation, repair, improvement, or expansion of a rural water system including distribution lines, wells and pumping facilities. Installation, repair or improvement of a rural waste disposal system are also included. Loans may not exceed \$20,000,000. Grants are limited to \$1,000,000.
Recreation	Farmers Home Administration, landowners	Recreation Facility Loans - These loans are intended to assist farm owners to convert all or portions of their farms to income-producing outdoor recreational enterprises to supplement farm income. Funds may be used to: (1) develop land and water resources, (2) repair and construct buildings, (3) purchase land, equipment, livestock, and related recreation items. Recreation enterprises that may be financed include: campgrounds, horseback riding stables, swimming facilities, shooting preserves, nature trails, and lakes and ponds for boating and fishing. Loans cannot exceed \$100,000.
	Landowners	Massachusetts General Laws, Chapter 27, Section 17C - The act limits the liability of landowners who allow recreational use of their property by the public. The obvious purpose of the act is to eliminate the liability that serves as a deterrent to providing recreational opportunities and which encourages the posting of land against trespass.
	U.S. Forest Service, Mass. Division of Forest and Parks, landowners	Recreation System of the Forest Service Renewable Resources Program assists landowners to provide forestland recreation opportunities. See the Land Use - Forestland Section for more details on the Renewable Resources Program.
	Mass. Department of Environmental Management	An Act to Protect Scenic and Recreational Rivers and Streams - This act authorizes the Commissioner of Environmental Management to adopt, amend, or repeal orders regulating or prohibiting dredging, filling or altering scenic and recreational rivers and streams. A Pilot Program under this act is being developed for the North River.
	Mass. Division of Conservation Services, municipalities, U.S. Bureau of Outdoor Recreation	Self-Help Funds, and Federal Land and Water Conservation Program - Chapter 132A, Section 11 of the General Laws assists conservation commissions in acquiring land for conservation and developing outdoor facilities. The Land and Water Conservation Fund also provides cost sharing assistance to finance recreation and open space programs.

CHAPTER 6

FUTURE-WITHOUT-PLAN CONDITION

6.1 DEFINITION AND USE

The Principles and Standards for Planning include a major step to "evaluate resource capabilities and expected conditions without any plan." This involves an appraisal of future economic and environmental conditions expected without a plan, so that these conditions may be compared with those desired by people for the planning area.

Thus, for a selected future date, projections are made which reflect the inventory and capabilities of the natural resources, the trends which are likely to continue into the future, and the effects of any authorized projects which may alter conditions in the region. The "without-plan" portion of the title implies that the future conditions are to be projected without consideration of any projects which may be in planning stages. This restraint makes it possible to project future conditions which could be expected in the absence of any new programs or projects. Obviously, it makes little sense to embark on an elaborate planning process followed by detailed implementation schemes, if existing authorized projects combined with expected changes will meet the projected demands in a resource area.

The Massachusetts Water Resources Study is concerned with projecting future conditions to the year 1990.

6.2 IMPLICATIONS OF ECONOMIC AND SOCIAL PROJECTIONS TO ENVIRONMENTAL CONSIDERATIONS

As Chapter 4 pointed out, 1990 population projections show an increase of 230,181, or nearly 18.4 percent greater than the 1975 population of 1,255,076. Economic activity is also projected to increase. The potential impact on the environmental quality in the region need not be adverse. Taking the 1990 land use projections, and subtracting agricultural land, lands of state and

local importance (including forestland presently located on these lands), wetlands, and water, 663,205 acres remain which are conducive to development. This figure would have to be adjusted downward to take into consideration slopes and soil conditions not amenable to development or septic systems. On this basis, it is concluded that enough land resource exists to adequately support future population and economic growth. What is required is land use control or guidance to insure that future development does not adversely affect environmental quality.

6.3 DESCRIPTION OF FUTURE-WITHOUT-PLAN CONDITION

6.3A. Agricultural Land

As noted in Chapter 5, existing land use laws and regulations have been incorporated in the projections (Chapter 4). The statutes that appear to be the most effective are those that have preservation as their primary objective. This explains, in part, why wetland projections show a small decline relative to the historical trends. Agriculturally related land use laws seem to have little effect on the losses of such land; thus, the historical trend was adjusted only to weigh the recent trends more heavily than the earlier trends. It should be noted that if current trends continue, the region will continue to lose agricultural land.

With respect to stated public policies and goals, especially regarding agricultural preservation and proper siting of future developments, the future is cloudy, at best. Subdivision control statutes are limited, since approval is not required if such developments occur along existing public roads. Unless additional controls are incorporated, land use guidance will not be forthcoming and, thus, there is some possibility that the resource base and the environment may be adversely effected. Without such guidance, review, or approval procedures, impacts of development will remain somewhat indeterminate.

In December of 1977, the General Court of Massachusetts enacted legislation which would provide \$5,000,000 to support a pilot development rights program wherein said rights are purchased from private landowners. The impact upon agricultural land preservation could be significant. For example, ownership costs (taxes) would be lower because assessments would be based upon agricultural production value rather than market value for developable land. Since development would not be permitted, farmland would therefore be less costly to purchase which may result in lessening the barriers to entry.

6.3B. Forestland

To determine the future-without-plan condition, it was assumed that forestland will continue to decrease at the low rate of approximately 338 acres per year, and that forest management efforts will continue at about 1976 levels. Presently, an estimated 133,000 acres are assumed to be under some type of forest management. The loss of forestland to urbanization will increase if the present efforts to maintain the farmland base are successful.

Wood Products -- Future urban development will have two effects on wood product production. It will decrease both the area available for wood production, and the average productivity of the region. Sites that are the best for growing trees are among the best for development. These sites will be among the first to be lost to urban expansion and the future productivity of the region will decrease. Only 19 percent of the trees removed in land clearing operations are utilized for forest products including fuelwood. So, land clearing does not contribute significantly to wood product production in the region.

Given the present support level for programs to provide incentives and to educate landowners on forest management, many will continue to let

their trees grow unmanaged. Landowner attitudes will discourage new wood-using industries from coming into the region, and there will continue to be a lack of a market for low quality products.

Fuel wood harvesting will increase because of the energy crisis, but this increase could be offset by the decrease in forestland area.

Future wood product production should remain constant or decrease slightly, given the above assumptions. The harvest will remain at about 3.4 million cubic feet per year, which will effect some 6,900 acres of forestland annually.

Water -- As long as an acre of land is in forest cover and a good forest floor is present, it will produce good quality water. Forestland will remain the dominant land use in the region; therefore, the forest resource will continue to supply a good quantity of high quality water.

Forage -- Grazing of livestock on forestland is not a major use now, nor will it become a major use in the future.

Wildlife -- The amount and kind of wildlife available in an area depends on the habitat in the area. The majority of the land area is forested, and there are many wetlands to provide diversity needed for good habitat. This is expected to continue into the future. With the small amount of harvesting taking place, the forests will mature, and this will change the kind of wildlife found in the area. As one stage of forest succession goes to another, the animal community associated with the first also gives way to a new community.

Even though wildlife will remain in the region, access to the wildlife for both consumptive and nonconsumptive uses will continue to be a problem. As the area becomes more urban and ownerships become smaller, there will be more posting of land.

Recreation -- Future recreation needs will not be fully met through the year 1990. The forestland has the physical capacity to support the development of almost any required number of campsites, picnic areas, and trails. The problem will continue to be one of public access and an insufficient number of developed facilities. (See Table 7.5)

6.3C. Inland Flooding

As a result of the National Flood Insurance Program, many communities in the region are adopting land use regulations which will severely restrict the development of flood prone areas. Flood plain development in towns which are not enrolled in the Flood Insurance Program will be limited by the unavailability of federally supervised mortgage money in flood prone areas. In addition, communities are becoming more cognizant of the importance of flood plain management to discourage improper land use.

As a consequence of the situation stated above, inland flood damage potential in most of the Central Region is not expected to significantly increase by 1990. Changes could occur in individual subwatersheds, if unexpected industrial or commercial development were to occur in the old mill buildings which are located along the region's rivers. Inflation will, of course, increase the total dollar damage potential, but the physical damage is expected to remain essentially unchanged.

There are three exceptions to this "future-without" plan condition. The first is the Baiting Brook Watershed located in Framingham, Massachusetts (subwatershed SU-16). This watershed has been approved for construction of a single purpose floodwater retarding structure, channel enlargement, and culvert improvement. Construction of this project under PL-566 will significantly reduce flood damage potential.

The second exception is on the Sudbury River (subwatershed SU-17) in Saxonville. A local protection project has been approved under the auspices of the Corps of Engineers which will reduce flood damages in this watershed.

The final and most significant exception is on the North Mashua River (subwatershed NA-2, 3, and 4) where the Corps of Engineers is now conducting detailed studies. Since these studies are not finalized, no reduction figure has been shown in the table. If alternatives being developed are implemented the major portion of damages, will be reduced.

Flood damages anticipated in 1990 are indicated in Table 6.1.

6.3D. Erosion and Sediment

Erosion problems resulting on logging roads, skidtrails, roadbanks, unpaved roads, gravel pits, streambanks and from improper harvesting of timber, are expected to be managed and controlled by existing programs and services. Existing programs, as presently administered, will not be able to bring erosion losses to an acceptable level on all cultivated farmland, construction areas, or related critical erosion areas, such as road cuts with unstable slopes, sand dunes, and utility rights-of-way. Without increased funding and emphasis, the Conservation Operations Program of the Soil Conservation Service is expected to meet less than 35 percent of the existing land treatment needs on cultivated cropland by 1990. Also without action to regulate and modify development practices, erosion losses of more than 175,000 tons per year are expected from the 4,500 acres of land being converted to urban uses each year.

6.3E. Wetlands

The future status of wetlands loss in the region will be largely determined by the effectiveness of the Wetlands Protection Act and the Inland and Coastal Wetlands Restriction Acts. The ownership and zoning of the wetlands and the HUD Flood Insurance Program are also factors in determining the potential for loss of wetlands.

TABLE 6.1

PROJECTED 1990 FLOOD DAMAGES 1/

Subwatershed	100-Year Flood Damage	Average Annual Damage
<u>-Merrimack River Watershed- 2/</u>		
ME-1 (Rowley River)		3/
ME-12 (Cow Pond Brook)		3/
ME-13 (Merrimack River)		3/
ME-14 (Stony Brook)		3/
ME-15 (Merrimack River)	1,444,300	68,700
ME-18 (River Meadow Brook)		3/
ME-19 (Shawsheen River)	1,242,000	74,500
ME-20 (Merrimack River)		3/
ME-21 (Merrimack River)		3/
<u>SuAsCo Rivers Watershed</u>		
<u>-Sudbury River Watershed-</u>		
SU-16 (Baiting Brook)	114,800	23,500
SU-17 (Sudbury River)	5,707,300	342,400
<u>-Assabet River Watershed-</u>		
AS-17 (Assabet River)	112,700	6,800
<u>-Concord River Watershed-</u>		
CO-17 (Concord River)	805,000	48,300
<u>-Blackstone River Watershed-</u>		
BL-61 (Ramshorn Brook)	285,200	17,100
BL-62 (Blackstone River)		3/
BL-63 (Quinsigamond River)	363,400	21,800
BL-64 (Blackstone River)	958,000	57,500
BL-65 (Mumford River)	2,066,000	124,000
BL-66 (West River)		3/
BL-67 (Mill River)		3/
BL-68 (Abbott Run)		3/
<u>-Thames River Watershed-</u>		
TH-1 (Furnace Brook)		3/
TH-1A (Quinnebaug River)	844,100	50,600
TH-2 (French River)		3/
<u>-Nashua River Watershed-</u>		
NA-1 (Souhegan River)		3/
NA-2, 3 and 4 (North Nashua River)	Detailed studies being conducted by Corps of Engineers.	
NA-5 (Quinapoxet River)		3/
NA-6 (Stillwater River)		3/
NA-7 (Nashua River)	201,300	12,100
NA-8 (Catcoonamug Brook)	115,000	6,900
NA-9 (Mulpus Brook)		3/
NA-10 (Squannacook River)	227,700	13,700
NA-11 (Nashua River)	281,700	16,900

1/ Price Base 1976.

2/ Does not include main stem damage.

3/ Average Annual Damage less than \$5,000.

Wetlands Protection Act applications have been reviewed for a sample of 85 communities in the state. The sample indicates that in 1976, nearly 290 acres of the 80,800-acres of inland wetlands in the sampled communities had received alteration permits. An analysis of building permit data for the last ten years showed that construction expenditures for 1976 were being made at a rate nearly 15 percent above the 10-year average. In view of this, the 1976 loss of inland wetlands figure, approximately 0.4 percent per year, is considered appropriate for use here.

Publicly owned wetlands are in less danger of being lost to development than privately owned areas. Surveys of the inland wetland areas indicated over 14 percent were owned by government or some quasi-public body, such as the Massachusetts Audubon Society or Trustees of Reservations. Zoning can also affect the rate of wetland loss. Conservation and flood plain zoning of wetlands will tend to preserve wetland areas, while industrial or commercial zoning indicates a potential danger to the wetlands. Nearly 21,000 acres or 26 percent of the inland wetlands are under special regulations, such as flood plains, wetlands, and conservation or other zoning.

Considering historical wetland losses, adjusted for variations in construction activity and factoring in the effects of public ownership and protective zoning, indicates a projected loss for inland wetlands of about 4,600 acres between 1977 and 1990.

Salisbury, the only town with coastal wetlands in the region, has had its tidal wetlands restricted under Massachusetts G.L., Ch. 130, Sec. 105, the Coastal Wetlands Restriction Act. This study will, therefore, concern itself with the region's inland wetlands only.

TABLE 6.2

1990 INLAND WETLANDS SITUATION & PROJECTIONS

	Acres	Percent of Total
Present status (1977)	82,019	100.
Wetlands in:		
Public or quasi-public ownership	11,559	14.1
In conservancy zones	20,970	25.6
G.L., Ch. 131, Sec. 40A restrictions on privately owned wetlands	691	0.8
Wetlands protected only by G.L., Ch. 131, Sec. 40 in 1977	48,789	59.5
Projections (1977 to 1990)		
Additional public acquisition	7,700	9.4
Additional Ch. 131, Sec. 40A restrictions	9,250	11.3
Projected loss of wetlands by development	4,590	5.6
Wetlands protected only by G.L., Ch. 131, Sec. 40 in 1990	27,249	33.2

Discussions with personnel involved with the inland wetland restriction program indicated that, if the programs continue at their present rate, restrictions will be imposed on over 9,900 acres of inland wetlands within its region by 1990. Presently, only one town has wetlands restricted under the Massachusetts Inlands Wetlands Restriction Program, G.L., Ch. 131, Sec. 40A. It is projected that 12 towns within the Nashua study area will have wetlands restricted under this program by 1990. The present and projected status of inland wetlands are given in Table 6.2.

6.3F. Water Supply

The Massachusetts Water Supply Policy Study concluded that 34 towns (43 percent) of the region will have an adequate supply of water in 1990. Twenty-seven towns (34 percent) will have a deficiency. Deficiencies range from less than 1 million gallons per day (mgd) for 14 towns to over 5 mgd for two towns. Except for Leominster and Holden, the towns predicted to have the greater water deficiencies by 1990 are along the eastern side of the region in the SuAsCo and Merrimack basins.

Seventeen towns or 24 percent of the region uses either individual wells or private systems or there is insufficient data to project needs for these towns. Proposals have been presented to alleviate some of the deficiencies by reducing excessive leakage in distribution systems, exploring for ground water resources, and by possible utilization of additional surface water storages. Various studies and proposals have been made, producing few actual commitments which will have any far reaching effects on the predicted shortages.

The Massachusetts Executive Office of Environmental Affairs has just completed a "Water Supply Policy Study" for the state. The study utilized available data whenever possible and updated population projections and safe yield estimates. Those desiring detailed water supply data should refer to this study.

Information concerning potential surface water reservoir sites which appear to be suitable for development as municipal water supply reservoirs is found in Appendix A of this report.

6.3G. Water Quality

An objective of the Federal Water Pollution Control Act Amendments of 1972 is the restoration and maintenance of the chemical, physical and biological integrity of the nation's waters. To achieve this objective, two major goals were established: (1) to attain swimmable-fishable waters by 1983, and (2) to achieve zero discharge of pollutants by 1985.

Point sources of pollution have been the major emphasis of the clean-up efforts to date. Hundreds of millions of dollars have been, and will continue to be, spent to meet the enormous costs involved in constructing and operating wastewater treatment plants.

Although the objective of the 1972 Amendments to the Water Pollution Control Act will be difficult to achieve and expensive, public sentiment for clean water is overwhelming. Major pollution problems still exist in the Blackstone, Nashua, and Merrimack Rivers. These are areas close to heavy concentrations of population and, thus, in areas where the demand for clean water for other uses is also great.

We concluded that the existing programs, authorities, and institutions are adequate to meet the water quality goals. "The basic need is for better use of these (existing) tools, not more tools."

Alternatives for meeting the remaining water quality problems are presented in detail in the following studies: Blackstone River Basin, Sene Study; Merrimack River Basin (which includes the Nashua, Concord, Sudbury, and Assabet River Basins), the Merrimack - Designs for a Clean River, U.S. Army Engineer Division, North Atlantic Corps of Engineers; Thames River Basin, 201 and 208 Studies.

The subject of water quality will not be carried further in this report except when it overlaps another concern such as land use, or erosion and sediment. These areas of overlap will be restricted to the water quality effects of non-point pollution sources and alternatives for minimizing the problem.

The Water Quality Management Plans being prepared under Section "208" of the Federal Water Pollution Control Act should go a long way toward meeting water quality goals in the region. The magnitude and seriousness of nonpoint pollution sources should be more clearly understood after completion of the plans. Measures to alleviate nonpoint problems will follow the evaluation of problem extent.

6.3H. Recreation

Recreational planning in Massachusetts is guided by the Statewide Comprehensive Outdoor Recreation Plan (SCORP) which projects demand figures to the

year 2000. Supply figures, however, are based upon currently available facilities. Comparison of 1990 demand figures with present supply indicates an unmet demand in hiking, camping, and picnicking. Alternatives will be presented in a later chapter which offer potential to meet some, but not all of the projected needs.

Of the 55 natural areas in the Central Region identified by the 1974 Massachusetts Landscape and Natural Areas Survey, 32 are now owned by public or private conservation organizations or institutions. By 1990, it is expected that an additional four sites will be acquired or protected, bringing the number of protected sites to 36.

Historical and cultural sites in the region are more than adequately identified and protected by ongoing efforts of federal, state, and local governments and private individuals and organizations.

Streams in the Central Region do not appear to meet the criteria of the Federal National Wild and Scenic River Act of 1968. The SCORP report indicated that 11 rivers have potential for protection under the Massachusetts Scenic and Recreational Rivers Act. Because of uncertainty about implementation of the program, we have assumed that no rivers will be protected under the act for the "future-without-plan" condition.

Public access to ponds and lakes in the region should be increasing in the future, although the magnitude of this increase is difficult to quantify. Conservation commissions are actively seeking to acquire prime areas, many of which are wetlands or include fresh open water. Appendix A. indicates the access status of public lakes, ponds and reservoirs. The Massachusetts Public Access Board has proposed the following additional public access sites in the region: Webster Lake, Webster; Bare Hill Pond, Harvard; Lake Quinsigamond, Worcester; North Pond, Hopkinton; Long Sought For Pond, Westford; and Forge Pond, Westford.

I. Fish and Wildlife

According to the Division of Fisheries and Wildlife, demand for fish and wildlife recreational opportunities over the next 25 years will increase but to an unknown degree dependent upon various positive and negative factors which are impossible to predict. Participation in hunting and fishing, however, is expected to increase at an average rate of one-half percent per year. Participation in nonconsumptive fish and wildlife recreational activities will likely increase under the stimulus of a state "non-game" program when such is established, and continued publicity involving rare and endangered species.

It is anticipated that the larger game mammals, waterfowl, raptors, upland game, and songbirds will continue to receive major public attention and support. Reptiles, amphibians, rodents, various less visible species, and those animals viewed as pests are expected to attract only minor attention.

CHAPTER 7

NEEDS

7.1 INTRODUCTION

Needs may be defined as the unmet demand which will not be satisfied by existing resource management, or by implementation of authorized plans or projects. The quantification of needs stems from the evaluation of resource capabilities and expected conditions without a plan. In effect, needs indicate the areas where additional planning, authorization, and implementation is needed to meet the desires of society.

7.2 LAND USE NEEDS

7.2A Agricultural Land

Table 7.1 summarizes the needs as determined from the future-without-plan condition relative to the stated problems and objectives. The primary need is to maintain or increase agricultural land. As Table 7.1 also shows, there are a number of subneeds that must be met in order for the primary need to be satisfied.

An interesting aspect within the land resource area is that, by solving the NED problem, much of the identified EQ problem (loss of open land) is also solved. Thus, the needs for the EQ objective in the land resource area are similar to those of the NED objective. There is some dichotomy, however, in that one of the objectives is to increase or, at least, maintain agricultural production. But if this is accomplished, the water resource quality may be adversely effected by continuing or increasing levels of nonpoint sources of pollution. Thus, as Table 7.1 summarizes, there is a need for an aesthetically pleasing land use mix, and if such a mix is derived from a continuation of agriculture, then there is another need to minimize nonpoint sources of pollution from agriculture.

TABLE 7.1

AGRICULTURAL LAND USE NEEDS

Primary Objectives	Resource Area	Needs
NED	Agricultural Land	<ol style="list-style-type: none"> 1. Reverse trend of agricultural land loss. 2. Insure proper land use planning to minimize future development on agricultural land. 3. Complete soil surveys.
EQ	Open Land	<ol style="list-style-type: none"> 1. Locate future developments so as to minimize locations on environmentally sensitive areas. 2. Complete soil surveys. 3. Preserve open land to contribute to an aesthetically pleasing land use mix. 4. Minimize nonpoint pollution agricultural sources.

One of the most important regional needs is to complete the soil survey. These surveys are extremely useful in providing an inventory of soil types, in providing soil interpretations for guiding certain land uses, and in providing critical area locations.

7.2B. Forestland

By the year 1990, there will be a need for an additional 3.6 million cubic feet of wood products for the region. Forestland needs are summarized in Table 7.2.

The first step in increasing production is to utilize and increase the management on public and private forestland for wood products. There will also be a need to increase the acreage of forestland utilization and management for wood products.

Many landowners require incentives to persuade them to manage and not develop their land for other uses. If a landowner is going to manage his land for forest products, he has to see the possibility of selling his products. There

is a need to develop diversified markets. To increase management on private forestland, many owners need to be informed of the opportunities and benefits of forest management.

Additional needs beyond the scope of the material included in this report are areas of study and measures that would complement and strengthen the forest industries. At the present time, the secondary wood-using industries reportedly draw much of their requirements for wood products from areas outside the state. There is a need to study the structure of these industries with a goal of supplying more of their needs from in-state milling plants. The primary processors would thus act more as an import substitution industry.

To increase or maintain the environmental quality of the area, there is a need to combine the urban and forest environments in a way that maintains some of the benefits of the forest environment. This can be accomplished by first informing towns about urban forest management, and, secondly, providing technical assistance to towns to manage their urban forestlands.

TABLE 7.2

FORESTLAND NEEDS

National Objective	Resource Needs	Needs	
		1980 3.0 Million Cubic Feet	1990 3.6 Million Cubic Feet
NED	Forestland	Increase the management of public and private land for wood products from the present 133,000 acres to 372,000 acres.	
		Increase incentives to landowners to manage their forestland.	
		Develop diversified markets for wood products.	
		Inform and educate landowners on the values of forest management.	
EQ	Forestland	Information and education program on forestland.	
		Provide technical services on forestland management.	

7.3 FLOODING

One of the objectives of this study of flooding is to develop alternatives to reduce flood damages to an acceptable level. The definition of "acceptable level" is subject to discussion. For purposes of this study, however, average annual flood damage of less than \$5,000 was considered an acceptable level. This is roughly equivalent to a 100-year frequency flood causing \$80,000 in damage. Subwatersheds needing alternatives to reduce flood damage are indicated in Table 7.3. The North Nashua River subwatersheds (NA-2, 3, and 4) have not been included, since detailed investigations are now underway by the Corps of Engineers.

TABLE 7.3 FLOOD DAMAGE REDUCTION NEEDS

Subwatershed	Description	Average Annual Damage 1/
ME-15	Merrimack River 2/	\$ 68,700
ME-19	Shawsheen River	74,500
CO-17	Concord River	48,300
AS-17	Assabet River	6,800
BL-61	Ramshorn Brook	17,100
BL-63	Quinsigamond River	21,800
BL-64	Blackstone River	57,500
BL-65	Mumford River	124,000
TH-1A	Quinebaug River	50,600
SU-16	Baiting Brook	23,500
SU-17	Sudbury River	342,400
NA-7	Nashua River	12,100
NA-8	Catacoonamaug Brook	6,900
NA-10	Squannacook River	13,700
NA-11	Nashua River	16,900

1/ Price Base 1977.

2/ Does not include main stem damages.

7.4 EROSION AND SEDIMENT

Major erosion and sediment control needs are concentrated in construction projects, about 2,500 acres of tilled cropland, and other critical erosion areas, such as streambanks, roads, etc.

7.4A Areas Undergoing Urban Development (construction sites)

From 1952 to 1972, approximately 6,400 acres per year of nonurban land were converted to urban use. During the construction period, soils are usually stripped of vegetative cover and are often left in this exposed condition for extended periods of time. The result can be severe erosion on the site and quantities of sediment released downstream. It is expected that 6,400 acres per year will be converted to urban use by 1990. Gross erosion from these areas is expected to exceed 250,000 tons per year.

7.4B Tilled Cropland

Erosion rates on approximately 20 percent of the tilled cropland exceeds the average tolerable loss of 3 tons per acre established for most soils. There are also individual farms within the region which have critical erosion problems, a few exceed the average erosion rate by more than ten times. Cropland treatment needs are good management and the use of good practices such as residue and cover, sod in rotation, contouring, strip cropping, and permanent cover. About 2,500 acres will require sound management and treatment by one or more of the preceding practices. Some of this acreage will require a return to a permanent vegetative cover to effectively control further erosion.

7.4C Critical Erosion Areas

In addition to these problem erosion areas, the region has some isolated critical erosion areas which are not being stabilized by existing programs. These critical areas include road cuts with unstable slopes, blowing sand from utility rights-of-way which have been scarred by off-road recreational vehicles, and blowing dust from gravel pits. Although these critical areas

are not regionally significant in terms of total volume of erosion, the erosion and its effects are locally significant and should be minimized.

7.4D. Streambanks

Streambank erosion, although not the major erosion source in terms of total erosion, is, however, a major problem from the standpoint of sediment delivered to watercourses. The 139-miles of major streams and 168 miles of tributaries which are considered to be susceptible to erosion have an annual erosion of 105,000 tons. There is a need to establish vegetative buffer zones along streams where erosion is occurring, and structurally stabilize the most critical areas where vegetative methods are not adequate.

7.5 WETLANDS

According to the wetlands projections in Chapter 6, by the year 1990, over 4,500 acres of inland wetlands will be lost to urban development. An additional 27,000 acres will be protected only by General Laws, Chapter 131, Section 40, the Inland Wetlands Protection Act.

The needs in the area of inland wetlands can be summarized as follows:

1. reduce projected wetland loss;
2. provide additional protection to the 48,200-acres of inland wetlands which are not protected by public ownership or the Inland Wetlands Restriction Act;
3. provide additional public access to inland wetlands for passive recreation.

7.6 WATER SUPPLY

Projections in Chapter 6 indicate 29 towns will have a public water deficiency by 1990. To alleviate this problem, there is a need to: (1) promote

conservation of water to include reduction of excessive leakage in existing distribution systems, controlling demand and protection of quality of existing water supplies, (2) locate additional ground water sources, and (3) utilize or at least preserve available surface water storage sites.

7.7 WATER QUALITY

Much is being done to alleviate the water quality problems in the region. However, there is a need to reduce nonpoint pollution sources from sediment, individual septic systems, and other nonpoint pollution sources. Detailed soil surveys are needed on at least 10 towns to effectively deal with the non-point pollution problem.

7.8 RECREATION

Recreation needs as indicated in Table 7.4 shows a surplus in the region of swimming, canoeing, and sailing facilities. However, local areas may be in need of these facilities, as their distribution does not always coincide with population.

TABLE 7.4 RECREATION NEEDS

Activity	1975 Supply (1000 Activity Days)	1990 Demand (1000 Activity Days)	1990 Need	1990 Facilities Needed Number	Unit
Swimming	10,951	10,447	(surplus)	-	-
Camping	363	427	64	307	sites
Picnicking	1,061	4,038	3,977	10,350	tables
Canoeing-Sailing	1,943	1,715	(surplus)	-	-
Hiking	860	3,270	2,226	830	miles

The needs figures require some explanation. These figures indicate that the Central Region is in a relatively good position in recreation, except for picnicking and hiking. However, the region borders the Boston Metropolitan area which is deficient in all five categories of recreation analyzed; also the demand for picnic facilities is now, and will continue to be, met by informal picnic sites, i.e., a blanket under a tree.

Likewise, a portion of the need for hiking trails may be met with something less than a formally mapped and labeled "trail." Utility rights-of-way, rural highways, and even city streets in an historical area, such as the Central Region, can serve to provide an enjoyable hiking experience.

There is also a need to meet the environmental quality objectives associated with recreation:

1. Outstanding natural areas need to be preserved.
2. Massachusetts Scenic and Recreational Rivers Act should be implemented within the region.
3. Five major rivers should have greenbelts or environmental corridors established. The Merrimack, the Concord along with its two major tributaries, the Assabet and the Sudbury; the Blackstone, and the Quinebaug Rivers should establish a program similar to the Nashua River greenway.

CHAPTER 8 ALTERNATIVES

8.1 INTRODUCTION

Alternatives designed to meet the needs expressed in Chapter 7 are presented in this chapter for each major study concern. Table 8.4 compares the alternatives with needs, and assesses the effectiveness of each alternative. Effects of the alternatives on national economic development, environmental quality, social well-being, and regional development are presented in Table 8.5. Table 8.6 summarizes the potential environmental effects of the alternatives.

8.2 LAND USE ALTERNATIVES

This section addresses the public policy alternatives that are relevant to the problems and needs identified in land use. One alternative is the continuation of present policies. Since such action would not have a positive impact on the problems and needs discussed in this report, the "without plan" alternative is omitted from further discussion.

8.2A. Agricultural Land Use Alternatives

It is apparent, from recent discussions with state officials, that there is an overriding concern to preserve or expand agricultural land in the hope that production in the agricultural sector may be maintained or increased. Related to this is the desire to maintain an attractive variety of land uses which will continue to provide a good aesthetic and environmental setting, in terms of wildlife habitat and scenic viewing.

Past measures enacted in most states, including Massachusetts, were based upon regulations (i.e., zoning ordinances) and incentives (i.e., agricultural assessments). It is apparent from the continuing loss of farmland that these approaches have not been effective. Regulations have been ineffective for two reasons: (1) Zoning an area, agricultural, does not necessarily

guarantee that agriculture will be practical. (2) Those owners whose land is zoned low density have a strong economic incentive to press for zoning variances. Historically, not only in Massachusetts, but in almost all states with zoning ordinances, applications for zoning variances are often approved.

The incentive or agricultural assessment approach was aimed at decreasing taxes to agricultural firms. Although this measure has made staying in agriculture easier, it has not precluded the selling of agricultural land to nonagricultural users, primarily because the tax penalties assessed on such transactions are small in comparison to the amounts received for those properties. Little, if any, research has been undertaken to determine exactly how much monetary assistance is required. An underlying thought in the preferential assessment approach is that only a limited assistance is necessary to keep agricultural firms viable.

A number of states have recently been considering other means by which agricultural land might be preserved. Vermont and Washington have enacted land sales excise taxes. In Washington, for example, no taxes are paid on land owned for 6 years or more, and then sold. However, for land owned for less than 1 year, and then sold, the tax amounts to 50 percent of the sales price. Vermont law is similar, though tax percentages may differ somewhat. The main purpose of these laws is to decrease speculative buying of agricultural land with the intent to sell quickly to nonagricultural uses.

A number of states, including Massachusetts, have passed legislation providing for the public purchase of development rights to agricultural land. Such a program is a combination of the regulatory and incentive approaches. It is regulatory, in the sense that agricultural areas must be designated for preservation, and it includes incentives, since the income derived from the buying of the development rights can be reinvested in the farm enterprise to increase efficiency and net borrowing power and, thereby, hopefully increase its competitiveness.

The public investment required in a development rights program is dependent upon the difference in the value of land used for agriculture and the value, if the land were used for development. Thus, areas in close proximity to higher value uses where demand is great would cost the public more per acre to purchase the development rights than areas located further away where the demand is less. After the development rights are purchased, no other uses would be permitted. Such a program has two advantages over those previously mentioned:

1. The sale of development rights will provide compensation to owners of restricted areas.
2. Prospective farmers will require less financial resources to enter farming, since land prices will be based more on the agricultural income potential than upon potential development values.

Table 8.1 summarizes the component needs of agricultural land and the various alternatives through which such needs may be satisfied.

TABLE 8.1 SYSTEMS FOR PRESERVING AGRICULTURAL LAND

Component Needs	A Zoning and Preferential Assessment	B Purchase Leaseback	C Development Rights	D Allotments
1. Maintain or increase agricultural protection.	No	Yes	Yes	Yes
2. Maintain or increase environmental and aesthetic qualities.	No	Yes	Yes	Yes

8.2B. Forestland

Chapter 7 listed both the NED and EQ needs of the forest resource. Based on these needs, four alternatives are presented. Each of these alternatives have specific activities which, when combined, make up the major alternative. One or all of these activities could be implemented. The alternatives and accompanying activities are:

1. Increase management of public and private land by increasing the number of personnel working on state land, and personnel providing technical assistance to private landowners.
 - a. Add one technician to work with service forester on CFM.
 - b. Add four foresters to provide management assistance to private landowners.
 - c. Add two technicians and 14 woods workers to work on state forestland.
 - d. Engage Professional forestry consultant firms to accomplish the assistance where applicable.
2. Increase incentives to landowners to encourage them to utilize and manage their forestland for timber products.
 - a. Increase Forest Incentive Program funding by \$62,000.
 - b. Change Chapter 61 of the Massachusetts General Laws (Classification and Taxation of Forestland) by eliminating the ceiling of \$400/acre value on forestland.
 - c. Increase Agricultural Stabilization and Conservation funds in counties where land is valued too high for Forest Incentive Program funds.
 - d. Change liability law to limit landowners' liability for injuries incurred in timber harvesting.
 - e. Revise nursery program to provide free trees to landowners.
3. Establish a program to increase and diversify the markets for forest products, to encourage the utilization of low quality products, and to provide increased marketing assistance to the existing wood-using industry.
 - a. Hire utilization foresters to work in the area at the county level.
 - b. Encourage the establishment of plants to utilize low quality products.
 - c. Develop a fuel wood management program.
 - d. Provide low interest loans for sawmill modernization.

4. Establish an information and education program to inform private landowners about the benefits of forestland management.
 - a. Hire two people to conduct an information and education program throughout the region.

The EQ needs listed in Chapter 7 can also be met with the above alternatives. The information and education program can inform urban as well as rural landowners. The increases in personnel can provide technical assistance needed in the urban areas.

8.3 FLOODING ALTERNATIVES

Flood damages can be minimized by careful planning and implementation of flood plain management techniques. Flood plain management programs should contain regulatory and corrective measures.

8.3A. Regulatory Measures

Regulatory measures do not prevent flooding but, instead, reduce the threat of damage or loss of life from floods by discouraging development on flood plains. Regulatory measures include flood plain regulations, development policies, land use restrictions, greenbelts or open space, and flood insurance. Tax adjustments and warning signs are related measures.

In order to limit flooding damage to existing properties in the flood plain, Flood Plain Management Programs should be established for each of the following study areas: Merrimack, SuAsCo, Nashua, Blackstone, and Thames. Flood plain restrictions on the Nashua River are presently being considered under Chapter 131, Sec. 40, a program to impose restrictions on selected flood plains. The National Flood Insurance Program, established on a community-by-community basis, would be a major element of any flood plain management program. All communities in the region should cooperate with the National Flood Insurance Program regulations and formulate effective flood plain restrictions, such as zoning and subdivision control.

The first flooding alternative would be to recommend that Ashby, Brimfield, and Dunstable join the National Flood Insurance Program as a first step towards establishing sound flood plain management programs.

8.3B Corrective Measures

Corrective measures, will not eliminate flooding, but can reduce the extent of flooding and resulting damages. These corrective measures are usually physical measures and can include land treatment, floodwater retarding structures, stream improvements, levees or floodwalls, existing reservoir management programs, floodproofing of structures, relocation, acquisition, flood plain reclamation, and flood watch and warning systems.

As noted previously, regulation of development on flood plains is expected to effectively limit increases in flood damages. Corrective measures will also be needed to reduce damage to existing development.

Corrective measures, as described below, are usually physical measures that are designed to reduce or control floods and flood damage.

Land Treatment -- Vegetative and mechanical land treatment measures can be installed on the uplands to prevent destruction of land by erosion and reduce the movement of damaging amounts of sediment to the streams and flood plains. Agricultural lands and lands in transition from agriculture to urban uses should be protected or maintained by temporary vegetation, mulch, sediment basins, or other measures to reduce and control erosion. Land treatment measures also slow or reduce runoff and peak flood flows from upland areas.

Floodwater Retarding Structures -- These structures are earthfill or concrete impoundments that check the uncontrolled flow of floodwater rushing downstream. The structures are located to protect the largest possible area of land subject to flooding, encroach as little as possible on high value lands, and provide a high level of protection to downstream property.

Stream Modifications -- Stream channel changes to increase channel capacity to carry floodwater can be made by straightening, deepening, widening, clearing, or by lining the channel so that flooding will be less frequent and severe.

Dikes and Floodwalls -- These are earth embankments or concrete walls built along the bank of a stream to confine flood flows to the channel or floodway. Dikes and floodwalls are normally used to provide protection to high value flood prone areas.

Floodproofing of Buildings -- Techniques used to make existing buildings, contents, and grounds located in flood hazard areas less vulnerable to flood damage are:

1. permanent measures built as an integral part of the structure, such as: raising the elevation of the structure, waterproofing of basement and foundation walls, anchorage and reinforcement of floors and walls, and use of water-resistant materials;
2. contingency measures which require action to be taken to make them effective, such as, manually closed sewer valves and removable bulkheads;
3. emergency measures carried out during floods according to prior emergency plans, such as sandbagging, pumping, and removal of contents to flood-free areas.

Flood Plain Reclamation -- This includes the permanent evacuation of developed areas subject to inundation and the acquisition of lands by purchase, the removal of structures, and the relocation of the population from such areas. Such lands could then be returned to a natural wildlife habitat or used for agriculture, low intensity recreation, or other purposes which would not interfere with flood flows.

Flood Watch and Warning Systems -- The National Weather Service of the National Oceanic and Atmospheric Administration issues warnings of potential flood producing storms. Frequently, the flood warnings are preceded by a "severe weather or flood watch."

Local programs can also be implemented to give advance warning to flood prone areas of potential or impending flood danger. On small watersheds with considerable swamp storage, staff gages set at key locations could be monitored by local personnel under the Water Watch Program. Monitoring could be accomplished by the use of float-activated electronic warning signals connected to the police or fire department. All warning systems should be coordinated with local Civil Defense disaster plans.

8.3C. Evaluated Alternatives

Three combinations of corrective measures were investigated to illustrate the range of possibilities available to reduce existing flood damage. These combinations are presented as flooding alternatives. A summary of the combinations, costs, and remaining damages is presented in Table 8.2.

Land treatment, floodwater retarding structures, stream improvements, and dikes and floodwalls were considered as one combination. These structural measures have been the traditional basis of federally-financed, flood control projects. Reduction in flood damage is achieved by reducing runoff and peak flows, or by confining flood flows to established channels or floodways.

Another combination investigated was a floodproofing program to modify existing damageable property. A wide range of techniques was considered to reduce damage at individual locations. Permanent measures, such as the waterproofing of walls, were combined with contingency measures, such as removable flood barriers to safeguard interior areas from floodwaters. Emergency measures to be carried out during floods, such as pumping and removal of damageable material to flood-free areas, were also included in this alternative.

TABLE 8.2 - SUMMARY OF ALTERNATIVES TO REDUCE FLOOD DAMAGE
(Thousand Dollars)

Sub-water-Sheet	Structural Alternative										Floodproofing Alternative										"Mixed Alternative"									
	1990					Alternative					Floodproofing					Alternative					"Mixed Alternative"					Floodproofing				
	Flood Damage	100-Year Flood	100-Year Average	Project Cost/	Project Benefits	Flood Damage	100-Year Flood	100-Year Average	Project Cost/	Project Benefits	Flood Damage	100-Year Flood	100-Year Average	Project Cost/	Project Benefits	Flood Damage	100-Year Flood	100-Year Average	Project Cost/	Project Benefits	Flood Damage	100-Year Flood	100-Year Average	Project Cost/	Project Benefits	Flood Damage	100-Year Flood	100-Year Average	Project Cost/	Project Benefits
	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
ME-15	1,144.3	68.7	863.3	52.1	95.0	6.6	16.6	16.5	274.9	16.5	362.0	30.3	52.2	142.6	8.6	337.0	28.6	60.1												
FE-19	1,242.0	74.5	707.3	42.4	280.0	19.3	32.1	13.7	223.3	13.7	251.0	21.0	60.8	165.2	10.0	405.0	30.0	64.5												
CO-17	800.0	48.3	713.0	42.8	50.0	3.5	5.5	10.6	176.2	10.6	244.5	20.5	37.7	44.2	8.9	274.5	20.2	39.4												
AS-17	112.7	6.8																												
EL-61	285.2	17.1	137.8	8.3	1,320.3	20.7	8.8	53.5	3.2	106.3	8.9	13.9																		
EL-63	363.4	21.8	301.3	18.1	144.0	9.9	3.7	193.2	11.6	95.4	8.0	10.2																		
EL-64	958.0	57.5	699.2	42.0	225.0	15.5	15.5	21.3	354.2	21.3	27.5	2.4	36.2																	
EL-65	2,066.0	124.0																												
TH-1A	844.1	50.6	533.6	32.0	52.6	4.5	18.6	27.7	90.6	7.6	22.9																			
SU-14	114.8	23.5																												
SU-17	5,707.3	342.4	1,076.3	64.6	283.0	19.8	277.8	24.9	280.0	23.5	317.5																			
NA-2,3 & 4																														
NA-7	201.3	12.1	40.3	2.4	8,058.1	555.1	9.7	25.3	34.7	2.9	10.6																			
NA-8	115.0	6.9	27.6	1.7	8,853.6	609.9	5.2	32.2	4.9	.4	5.0																			
NA-10	227.7	13.7	103.5	6.2	90.0	6.2	7.5	39.5	59.6	5.0	11.3																			
NA-11	281.7	16.9	51.8	3.1	517.5	38.3	13.8	121.1	44.2	3.7	9.3																			

Price Base 1977
2/ Mortized at 6-3/8 percent for 100 years.

A third plan included the same structural measures, but combined them with floodproofing. Land treatment, floodwater retarding structures, dikes and floodwalls were used to reduce and control flood flows to manageable levels. Floodproofing measures were then utilized to reduce damage remaining from the reduced flows.

A large part of the damageable property in the region is not suited to economical floodproofing. Much of the road and bridge damage can only be reduced by reducing floodflows or enlarging the bridge. In other instances, floodproofing can create a potentially dangerous situation by giving residents a false sense of security. Residents may choose to remain in their floodproofed homes, when the more prudent action may be to evacuate to higher ground.

By utilizing floodproofing, in combination with structural measurements, it is often possible to reduce the cost and scope of a structural program while increasing the degree of protection afforded to the area.

Detailed investigations and analyses would be required to establish the most acceptable and effective combination of measures to reduce flood damages in the region. The three combinations considered in this study illustrate a range of possibilities. Final selection of a plan would require significant local inputs, consideration of environmental impacts, and a cooperative effort by local, state, and federal agencies.

8.4 SEDIMENT AND EROSION ALTERNATIVES

8.4A. Construction Areas

Provisions should be made for the retention of optimum amounts of vegetative cover for watershed protection on all areas undergoing residential, highway, and industrial development and construction. Developers should prepare and follow plans designed to minimize the disruption of the hydrologic balance and the resulting erosion, by maintenance of vegetative cover during construction. Contractors should utilize the natural landscape in their planning for environmental purposes. Where needed, developers and contractors should apply erosion

control measures, such as temporary debris basins or desilting basins, seed and mulch exposed areas, create temporary diversions, and retain forest buffer zones during construction. Adequate planning prior to construction and close supervision of construction activities are needed to control erosion.

Naturally, some developers will be reluctant to utilize erosion control measures, unless they can see some financial, aesthetic, or other tangible results. Consequently, we feel that sediment and erosion control ordinances and bylaws are needed to ensure compliance with good conservation practices during construction. These ordinances could be additions to present zoning, subdivision regulations, and/or building regulations.

8.4B. Streambank Erosion

Much of the streambank erosion in the region is aggravated by development or activity which occurs too close to the streambank, destroying vegetation and mechanically moving bank material into the stream. In order to protect streams from this erosion pollution danger, we recommend the establishment and maintenance of stream buffer zones within 50 feet of the rivers and streams of the region. These zones should be maintained in forest or other permanent vegetative cover. In many cases, this buffer strip will not completely stabilize the streambank and structural measures, such as rock riprap may be necessary. Vegetative means if not completely successful in stabilizing streambanks, will reduce the problem significantly.

8.4C. Tilled Cropland

The Conservation Operations Program of the Soil Conservation Service can assist landowners in applying conservation measures to prevent erosion on cropland. This technical assistance is coordinated through the conservation district and, in many instances, landowners can obtain cost sharing for installation of practices from the Agricultural Stabilization and Conservation Service.

Fiscal and personnel limitations make it necessary to establish priorities for technical and financial assistance. Priorities for technical assistance are provided by the conservation district board of supervisors in each county. Financial cost sharing program priorities are established by the Agricultural Stabilization and Conservation County Committee.

Since the installation of conservation practices is a purely voluntary effort on the part of landowners, priorities have tended to favor those farm operators who exhibit the most initiative and desire to install practices. The majority of technical assistance work is precipitated by landowner requests. This procedure has resulted in a good deal of assistance being provided to operators who are already highly motivated to install practices and who are aware of the benefits to be obtained from soil conservation efforts.

As a result of priority procedures and limitations on personnel and funding, many of the farms with severe erosion problems have not received much encouragement to install practices to alleviate the situation. However, these are the very operators who require the most encouragement, assistance, and continued follow-up, if they are to reduce erosion losses.

Cost sharing for conservation practices has favored production-oriented measures rather than erosion control practices. Naturally, the practices which are aimed toward increased production and increased farm income are popular with farmer-recipients. Erosion control practices which may result in a decrease in production tend to be less popular, though no less necessary.

If erosion losses on tilled cropland are to be reduced to acceptable levels, more emphasis will need to be placed on locating, contacting, encouraging, and assisting the farmers with the most severe problems. Since it appears unlikely that significant increases in funding or personnel levels will be forthcoming, other technical assistance and cost sharing measures will need to receive reduced emphasis.

A first step in reducing cropland erosion losses should involve a detailed cropland inventory to assess erosion losses and determine needed treatment for each farm in the conservation district. Priorities for assistance could then be established. SCS technicians should have definite annual goals to contact and assist high priority farm owners. Cost sharing assistance for erosion control practices on priority farms should be allocated the maximum possible funding; even if this acts to the detriment of some of the more popular production-oriented measures presently cost shared.

8.5 WETLANDS

In order to reduce projected wetland losses and to provide additional protection to inland wetland areas, this study has developed a hierarchy of protective measures to be pursued. This hierarchy is based upon the degree of protection provided to the wetlands against unwise development. The basic preference list is, as follows:

1. Public and Quasi-public Ownership.
2. Restrictions under Massachusetts General Laws, Chapter 131, Section 40A, the Inland Wetlands Restriction Act.
3. Conservancy Zoning, or other special zoning regulations.
4. Protection under Massachusetts General Laws, Chapter 131, Section 40, the Wetlands Protection Act.

This list of options was then employed to assist in the development of alternatives for additional wetlands protection.

8.5A. Public Acquisition

Accelerated acquisition of inland wetlands by state, county, city, and town agencies could be implemented to add to the projected acquisition of 7,700 acres. State agency acquisition of wetlands will continue to utilize existing funds, such as the Inland Fish and Game Fund. In order to accelerate acquisition, particularly the wetlands for wildlife program of the Massachusetts Division of Fisheries and Wildlife, additional funding from the Massachusetts legislature will be needed.

The Massachusetts Self-Help program should be funded on a regular basis. The U.S. Bureau of Outdoor Recreation's Land and Water Conservation Fund financing has been increased. A portion of the Self-Help funds and some of Massachusetts' share of the Land and Water Acquisition Fund should be earmarked for wetlands acquisition.

Projections indicate that about 7,700 acres of wetlands will be acquired by 1990 through existing programs. A reasonable goal for additional acquisition is 8,000 acres.

Priority for wetlands acquisition should go to the larger wetlands of the regions. These larger areas offer more potential for wildlife habitat than a like acreage of smaller units. Management of a large area is also likely to be easier than management of several smaller areas. In addition, the large areas offer the potential for lower per-acre acquisition costs as the interior portions of the areas are likely to be without road access and be less valuable real estate.

The 59-wetlands evaluated by the Soil Conservation Service and further described in Chapter 5 are among the largest wetlands in the region. Those with the highest ratings are shown in Table 8.3.

TABLE 8.3 WETLANDS WITH THE HIGHEST RATINGS

Wetland	Size (acre)	Approximate percentage Publicly or Quasi-publicly Owned
M-11, Bennetts Brook Wetland	142	0
S-2, Concord River Wetland	1,373	80
S-4, Hog Swamp	277	0
S-8, Sudbury River	3,436	50
S-9, Cedar Swamp	1,583	30
S-11, Indian Brook Wetland	359	70
N-1, Nashua River Wetland	467	100
N-12, Chaffin Pond Wetland	150	0
B-3, Cider Mill Swamp	238	0
B-7, Rice City Pond Wetland	105	0
B-8, Hopedale Pond Wetland	138	70
T-3, French River Wetland	140	0
T-9, East Brimfield Reservoir Wetland	654	100

These highest rated wetlands should be considered for early public acquisition.

8.5B Inland Wetlands Restriction Act

Progress in implementing the Restrictions Act has been agonizingly slow. Problems have resulted from the low staffing levels and the complexity of the project. Identification and location of wetland areas have been proceeding at an acceptable rate. The time-consuming procedures involve transfer of wetlands data to assessor's maps, determination of wetland tract ownership, and preparation of legal descriptions of each piece of wetland scheduled for restriction. A significant increase in staff and funding for the Restriction Program is needed, if more rapid results are to be obtained.

8.5C Protective Zoning

Conservancy zones can be a useful tool for the protection of wetlands. Flood plain zones, wetland zones, and conservancy zones usually place significant restrictions on development. Over 20,900 acres of inland wetlands are now in some form of protective conservancy zoning. In some instances, only the major wetlands in a town have been included in the conservancy zone.

Communities are encouraged to establish conservancy zones to protect their inland wetlands from unwise development. Such zoning should be comprehensive and include, as a minimum, all identified wetland areas above 5 acres in size. Communities with partial zoning of wetland areas are encouraged to expand coverage to include all wetland areas of significant size.

8.6 WATER SUPPLY ALTERNATIVES

Appendix A of this report identifies 83 locations which have potential as municipal water supply reservoirs. Topography of the potential storage basin, geology of the abutments and foundation, and land rights costs appear to be favorable.

Information in Appendix A was abstracted from the Inventories of Potential and Existing Upstream Reservoir Sites prepared by the Soil Conservation Service in

cooperation with the Massachusetts Water Resources Commission. Data is based on reconnaissance level investigations, and much more detailed investigations are needed before any of the sites could be developed as a municipal water supply storage.

Communities in need of water supply are encouraged to study the possibilities offered by these potential reservoir sites and to take the necessary acquisition or zoning steps to protect suitable sites from development.

The Water Resources Commission can acquire water impoundment sites to meet the future water resources needs of the Commonwealth as authorized by Chapter 767 of the Acts of 1970, Massachusetts General Laws.

8.7 WATER QUALITY ALTERNATIVES

Nonpoint pollution sources need to be evaluated to determine the magnitude of their effect on water quality. Results of the Section "208" water quality studies being conducted by regional planning agencies should give an indication of the extent of nonpoint pollution problems in the region.

Local communities should place more emphasis on soils limitations when planning for growth. Detailed soil surveys made in region towns indicate severe limitations existing for septic tank systems. Communities adopting or updating local zoning ordinances need detailed soils information to intelligently guide growth to suitable areas. In some cases, the use of large residential lot size, in certain soils, can minimize septic tank-leach field problems which might develop if smaller lot size and greater density of development were permitted. Conversely, smaller lot sizes may require sewage collection systems because of inadequate soils for onsite disposal.

On the basis of projected population increases and the lack of complete municipal sewerage, the following communities should obtain detailed soil surveys from the SCS to aid in guiding growth:

Carlisle	Groton	Lancaster	Marlborough	Upton
Dunstable	Lunenburg	Southborough	Framingham	Uxbridge

8.8 RECREATION

The following NED alternatives 7-1 thru 7-3 and EQ alternatives 7-4 thru 7-6 are presented to meet the 1990 recreational needs.

- 7-1 Camping - Provide an additional 100 campsites at Wells State Park, Sturbridge or at some other campground in the eastern portion of SCORP Region III, Central Highlands. Provide a total of 200 additional campsites, at Lowell-Dracut State Forest, Upton State Forest, and Hopkinton State Park.
- 7-2 Picnicking - Provide an additional 2,800 picnic tables. This will approximately double the present supply within the region. These tables could be located on state forest and parks, town lands, and also the private sector could contribute towards reducing this need.
- 7-3 Hiking - Provide hiking trails within proposed greenbelts for the five major rivers. This could add over 100 miles to the state's trail system. Linking trails to the existing Massachusetts Commonwealth Trail System and presently proposed additions to this system should be considered.
- 7-4 Promote acquisition of the additional natural areas identified in the 1974 Massachusetts Landscape and Natural Areas Survey. It is anticipated that 37 of the 55 natural areas will be adequately protected by 1990 under ongoing programs.
- 7-5 Implement the Massachusetts Scenic and Recreational Rivers Act within the region.
- 7-6 Establish greenbelt programs similar to the Nashua River Greenway Program for an additional four rivers in the region - the Merrimack, SuAsCo (Sudbury, Assabet, and Concord Rivers), Blackstone and Quinebaug Rivers.

8.9 COMPARISON OF ALTERNATIVES AND NEEDS

Alternatives and needs were compared for each study concern by national objective. This information is summarized and displayed in Table 8.4.

TABLE 8.4

COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Land Use Agricultural Land	1-1 Ignore situation and continue to let market forces operate to the demise of the agricultural sector.	1. Would not generate any positive solution to expressed needs.
		1-2 Undertake a multi-faceted program whereby state and local officials, public and private institutions would actively press for public programs to preserve agricultural land by keeping land in agricultural production.	1. Would directly and indirectly have a positive impact on meeting the expressed need of maintaining or increasing the agricultural base.
	a. Identify sources of comparative disadvantages and develop public policies and programs to minimize the disadvantages wherever possible.	a. Would increase economic viability and thereby contribute to reversing the trend of agricultural land loss.	
	b. Complete soil surveys to determine most feasible locations of future developments while prohibiting their location on productive agricultural lands.	b. Would minimize adverse impacts of development upon agriculture and would contribute to EQ needs as well.	
	c. Form task force to determine negative impacts of presently enacted and future legislation upon the agriculture sector and revise such legislation to minimize adverse impacts.	c. Would potentially help to minimize the impact of some ordinances (e.g., zoning ordinances) that promulgate specific goals but create incentives which are in opposition to those goals.	
	d. Form task force to actively seek public programs to provide incentives for food and fiber processing and marketing firms to locate in the region.	d. Same as a. above.	
	e. Form research task force to develop or locate new crops, crop and livestock products, which could be produced in the region and thereby increase diversity of production.	e. Same as a. above.	
	Land Use Forestland	1-3 Increase management of public and private forestland by increasing personnel working on state land, personnel providing technical assistance to private landowners, and by employing professional consulting foresters.	1. Will meet about 45 percent of the 1990 needs for wood products.
			2. Increase the acres managed by about 51 percent.
			3. Adequately meets the need for technical assistance on urban forest management.

TABLE 8.4 - cont.

COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives		Comparison with Needs
NEP	Land Use Forestland	1-4 Increase incentives to landowners to encourage them to utilize and manage their forestland for timber.	1.	Will meet about 43 percent of the 1990 needs for wood products.
			2.	Increase the acres presently managed by about 48 percent.
			3.	Will meet the need for increased incentives in the area.
		1-5 Establish a program to develop diversified markets for forest products.	1.	Will meet about 14 percent of the 1990 needs for wood products.
			2.	Increase the acres presently managed by about 16 percent.
			3.	Over a period of time this program will meet nearly all the needs for diversified markets.
NEP & EQ	Land Use Forestland	1-6 Establish an information and education program to inform private landowners about the benefits of forestland management.	1.	Will meet about 20 percent of the 1990 needs for wood products.
			2.	Increase the acres presently managed by about 22 percent.
			3.	Adequately meet the needs for knowledge on forestland management.
			4.	Adequately meets the need for knowledge on urban forestland management.
NEP	Flooding	2-1 Nonparticipating cities and towns participate in the HUD Flood Insurance Program.	1.	Limits future development of flood-prone areas and encourages communities to consider flood hazards when planning growth.
		2-2 Implement structural measures to reduce flood damage in the following subwatersheds: ME-15, ME-19, CO-17, BL-64, TH-1A, SU-17 and NA-10.	1.	Reduces average annual flood damage from \$10,927,400 to \$4,701,200.
		2-3 Implement floodproofing measures to reduce flood damage in the following subwatersheds: ME-15, ME-19, CO-17, BL-61, BL-63, BL-64, TH-1A, SU-17, NA-7, NA-8, NA-10, and NA-11.	1.	Reduces average annual flood damage from \$12,174,000 to \$2,375,000.

TABLE 8.4 - cont.

COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Flooding cont.	2-4 Implement a combination of structural and flood-proofing measures to reduce flood damage in the following subwatersheds: ME-15, ME-19, CO-17, TH-1A and SU-17.	1. Reduces average annual flood damage from \$9,741,700 to \$922,000.
EQ	Erosion & Sediment	3-1 Establish erosion and sediment control ordinances in municipalities with the most potential for urban development. 3-2 Establish and maintain stream buffer zones with forest and other permanent vegetative cover, within 50 feet of the region's rivers and streams.	1. Reduces erosion on the 6,400-acres per year undergoing urbanizing development. 1. Reduces erosion from the area with the greatest potential for stream degradation through sedimentation.
NED	Erosion & Sediment	3-3 Establish program by SCS aimed at eliminating high erosion losses on "problem" farms of region. Inventory conservation measures and follow-up procedure.	1. Reduces high soil losses on 2,500 acres, 20 percent of tilled cropland.
EQ & NED	Wetlands	4-1 Accelerate wetlands acquisition programs to acquire an additional 8,000 acres of regionally important wetlands. 4-2 Expand conservancy zoning or other special zoning regulations for wetland areas.	1. Reduces projected wetland loss. 2. Provides public access to inland wetlands for passive recreation. 1. Reduces projected wetland losses. 2. Provides additional protection to the 52,800 acres of inland wetlands which are not protected by public ownership, or the Inland Wetland Restriction Act.
EQ	Wetlands	4-3 Accelerate the Inland Wetlands Restriction Program.	1. Reduces projected wetland losses.
NED	Water Supply	5-1 Communities investigate water supply opportunities offered by the 83 reservoir sites identified in Appendix A.	1. Identified reservoir sites have potential to supply nearly 114 million gallons per day of safe yield.

TABLE 8.4 - cont. COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Water Supply cont.	5-2 Potential reservoir sites which can meet community water supply needs are acquired or otherwise protected from development which would make them unavailable or prohibitively expensive when needed as water supplies.	1. Reservoirs which have potential to meet a specific community need for water supply will be available when needed.
EQ	Water Quality	6-1 Obtain detailed soil surveys and use them to guide growth in the following communities: <div> <div>Carlisle</div> <div>Dunstable</div> <div>Groton</div> </div> <div> <div>Lunenburg</div> <div>Lancaster</div> <div>Southborough</div> </div> <div> <div>Marlborough</div> <div>Framingham</div> <div>Upton</div> <div>Uxbridge</div> </div>	<ol style="list-style-type: none"> 1. Reduces the potential harmful effects on water quality caused by malfunctioning septic tank systems located in unsuitable soils. 2. Has benefits in the area of land use by directing development away from "sensitive areas." 3. Has benefits in land use (agricultural land) by identifying prime agricultural land and land of state and local importance for farming.
NED	Recreation	<ol style="list-style-type: none"> 7-1 Provide 300 additional campsites within region. 7-2 Provide an additional 10,350 picnic tables. 7-3 Provide over 100 miles of hiking trails along major river corridors. 	<ol style="list-style-type: none"> 1. Meets 1990 needs. 1. Supplies approximately 25 percent of 1990 needs. 1. Supplies approximately 12 percent of 1990 needs.
EQ	Recreation	<ol style="list-style-type: none"> 7-4 Acquire an additional six natural areas as identified in the 1978 Massachusetts Landscape and Natural Area Survey. 7-5 Implement Massachusetts Scenic and Recreational Rivers Act in region. 7-6 Establish greenbelts (similar to Nashua River Greenway) in four additional major rivers: Merrimack; Concord and its tributaries, Assabet and Sudbury; Blackstone; and Quinebaug Rivers. 	<ol style="list-style-type: none"> 1. Will help maintain region's supply of natural areas. 1. Will help maintain riverine resources. 1. Same, plus provide recreational use. 2. With improvements in water quality underway, these river corridors will have much greater recreation potential.

8.10 ALTERNATIVE ACCOUNTS DISPLAY

The Water Resources Council's Principles and Standards for Planning of Water and Related Land Resources require that a system of information accounts be established to display beneficial and adverse effects of each alternative proposed to meet an objective. The effects of each alternative on national economic development environmental quality, regional development and social well-being are indicated to provide a basis for comparing alternatives. The purpose is to display beneficial and adverse effects so that different levels of achievement of each objective and trade offs between alternatives can be discerned and compared. These beneficial and adverse effects are displayed in Table 8.5.

8.11 POTENTIAL ENVIRONMENTAL IMPACTS OF ALTERNATIVES

Each alternative was evaluated to determine what significant environmental impacts, if any, it would have on the region. These findings are displayed in Table 8.6.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>1-Land Use</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Adverse Effects</u>	<u>Adverse Effects</u>
1-1 Agricultural Land - continue present land policies.	<p>Minimizes public costs relative to preservation programs.</p> <p><u>Adverse Effects</u></p> <p>Projected loss of 22,623 acres and net income potential from lost production.^{1/}</p> <p>Pro-rated cost of administering zoning ordinances.</p> <p>Loss of tax revenue from agricultural-horticultural assessments.</p>	<p>Continuing loss of agricultural land will decrease amounts of herbicides, pesticides and fertilizer nutrients entering water resources through runoff.</p> <p>Less erosion and sedimentation resulting from less land being cultivated.</p> <p><u>Adverse Effects</u></p> <p>Less diversified land use mix, thus lowering the aesthetic quality of the region.</p> <p>Adverse impact upon wildlife feeding habitat through a decrease in boundary areas of open and forestland.</p>	<p>Adverse to the extent that loss of agricultural production results in loss of input and output agricultural service and marketing facilities.</p>	<p>Decrease in agricultural land decreases the aesthetic qualities of the area.</p> <p>Increase in food costs to extent of increased transportation charges for increased food imports.</p>

^{1/} Approximate agricultural valuations (state averages) were computed by Dr. E. Engle, Department of Food and Resource Economics; University of Massachusetts (1974) for eight categories of agricultural land. Shade tobacco and nurseries: \$480-720/acre; binder tobacco, vegetables, potatoes: \$150-230/acre; cropland, pasture (tillable): \$110-170/acre; orchards: \$160-240/acre; cranberry bogs: \$560-840/acre; untiltable permanent pasture: \$40-60/acre; farm woodland: \$20-30/acre; nonproductive farm woodland: \$5-7/acre.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>I-Land Use - cont.</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>
1-2 Agricultural land - Net earning and subsequent tax revenues that would be lost without preservation.		Benefit would be derived to the extent that preservation of agricultural land would enhance the aesthetic qualities of diversified land use mix.	Benefits accrue to the extent that rates of unemployment and underemployment fall relative to such rates if land were not preserved.	Social well-being is enhanced to the extent that preservation measures enhance the aesthetic qualities of the region.
Food cost savings to extent that decrease in food products would be imported from other areas, thus increasing food prices.		Maintaining agricultural land would preserve boundary areas which would enhance wildlife habitat.	Much tourism due to aesthetic qualities which are enhanced through the maintenance of a diversified land use mix. Benefits accrue to the extent that agricultural land enhances the tourist industry.	To the extent that preservation measures result in lower food prices than would exist without a Preservation Program, SW-B is increased.
Preservation would preclude the projected annual loss of agricultural production value (between \$4,064,901 and \$12,383,007, 1967 constant \$). 2/		<u>Adverse Effects</u>		<u>Adverse Effects</u>
	<u>Adverse Effects</u>	Increases pesticide, herbicide and other residues entering water areas through runoff has a detrimental impact on environmental quality.	<u>Adverse Effects</u>	To extent society is adversely effected by noise and smells of agricultural production.
Costs of preservation measures more expensive than present policies. 1/				
A. Purchase lease-back program: Initial cost of purchase (\$600-\$3,000 per acre) minus revenues derived from renting to agricultural entrepreneurs.		Increased erosion and sedimentation resulting from cultivating preserved acreage.	One potential adverse impact stems from the development that would occur on the preserved acreage without a preservation program and that which would not occur with a preservation program. Although there is enough developable land in the region, even with a Preservation Program, added costs of developing nonpreserved land may result in some firms locating elsewhere.	
B. Development Rights Program: Cost of Purchasing Development Rights.				

1/ Values of agricultural land in the region are dependent upon provision of roads, water, sewer, electricity and physical characteristics. A purchase lease-back program would involve a \$600-\$3,000 range. Prices that would be relevant for a Development Rights Program would be to determine an acceptable rate of return per acre and from that determining the capital cost of purchasing that land based on an acceptable return and subtracting the capital cost/acre from the market value of the land. This program is further complicated by the fact that, although almost all agricultural land is zoned residential, much land would not be developed due to location of flood plains, wetlands, and/or the physical characteristics of the land itself. Thus, under these circumstances, prices of development rights would be negligible.

2/ Value of lost production computed by multiplying average value of production per acre (expressed in constant 1967 dollars) times the projected range of agricultural acreage decline.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>1-1 Land Use - cont.</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>
1-1 Increase management of public and private forestland by increasing personnel working on state land and personnel providing technical assistance to private landowners, and by employing professional consulting foresters.	Sawtimber-1,600,000 c.f./yr. valued at \$829,000 Pulpwood-95,000 c.f./yr. valued at \$21,000 Recreation General-83,000 V.D./yr. valued at \$166,000 Recreation Special-344,000 V.D./yr. valued at \$1,679,000 Water-3,800 A.F. valued at \$9,500. <u>Adverse Effects</u> Variable costs-\$214,000/yr.	Increase in technical services for urban forest management. Improvement in wildlife habitat by creating a more diverse forest cover. Increased management and protection enhances the benefits provided by forestland. Increase in technical assistance insures the protection of the quality of soil, water and aesthetics. <u>Adverse Effects</u> Possible minor increase in erosion and sediment.	Increase employment by hiring 4 professionals, 3 technicians and 14 woods workers. Increase in cut provides additional wood for presently underutilized mill capacity; provides increase in income to loggers and mills from additional wood; provides increase in revenues from tourism. Increase in industry employment because of increase harvest. Increase in recreational employment because of increase in visitor days.	Increased employment from more state, industry and recreational employment.
<u>1-2 Increase incentives to landowners to encourage them to utilize and manage their forestland for timber.</u>	<u>Beneficial Effects</u> Sawtimber-1,400,000 c.f./yr. valued at \$725,000 Pulpwood-700,000 c.f./yr. valued at \$155,000 Recreation General-30,000 V.D./yr. valued at \$60,000 Recreation Special-130,000 V.D./yr. valued at \$634,000 Water-1,800 A.F./yr. valued at \$4,500. <u>Adverse Effects</u> Variable Costs-\$620,000/yr.	<u>Beneficial Effects</u> Increase in forest management promotes and enhances benefits derived from forestland for now and in the future. More forestland managed; decreases loss to urban development.	<u>Beneficial Effects</u> Increases in regional income due to increase timber harvesting and recreation V.D. Enhances future employment because of increased forest productivity.	<u>Beneficial Effects</u> Increases the present and future employment.

1/ V.D. = Visitor Days.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>1-Land Use - cont.</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>
1-5 Establish a program to develop diversified market for forest products.	Sawtimber-178,000 c.f./yr. valued at \$922,000 Pulpwood- 372,000 c.f./yr. valued at \$83,000 Recreation Special-112,000 V.D./yr. valued at \$547,000 Water-10,200 A.F. valued at \$25,500. <u>Adverse Effects</u> Variable Costs-\$93,000/yr. Implementation Costs-\$750,000.	Increase in utilization promotes increase in wildlife habitat and provides better forest management practices. Provide market for forest products from land clearing, decreases burning and land fills. <u>Adverse Effects</u> Increases in erosion and sediment minimal.	Increase in employment dependent upon plant size. Addition of two professionals to state employment. <u>Adverse Effects</u> Implementation cost of \$750,000 by private industry. Annual operating cost of \$93,000.	Increased employment from industry and state. Increased recreation close to urban centers.
<u>1-6 Establish an information and education program to inform private landowners about the benefits of forestland management.</u>	<u>Beneficial Effects</u> Sawtimber-690,000 c.f./yr. valued at \$357,000 Pulpwood-72,000 c.f./yr. valued at \$16,000 Recreation General-780,000 V.D./yr. valued at \$1,560,000 Recreation Special-409,000 V.D./yr. valued at \$1,996,000 Water-600 A.F./yr. valued at \$1,500. <u>Adverse Effects</u> Variable Cost-\$36,000/yr.	Provide information to urban forest landowners on management opportunities. Urban forestry technical assistance will help make development of forestland more environmental and aesthetically sound.	Increase income to area by increasing visitor days, valued at \$3,556,000. Increased income from an increase in employment from more recreation and timber harvesting.	More aesthetic urban environment Increased employment. Increase in recreational opportunities close to urban centers.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>2-Flooding</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
2-1 Nonparticipating cities and towns participate in the HUD Flood Insurance Program.	Prevents increases in damageable properties.	Renewable resource lands (flood plains) protected as a result of required land use regulations.	Prevents increases in damageable properties.	Psychological satisfaction from the action.
Joining the program entails establishing effective flood plain restrictions; such as, zoning, subdivision controls and building regulations for development within the flood plains.	<u>Adverse Effects</u> \$100,000 initial cost of program. \$4,000 per year for operation and management of program.	Tends to maintain existing water quality by preventing building development close to streams. Maintenance of streamside habitats minimizes hazards to endangered species of animals, fish and plants.	Prices of buildable land may go up, thus increasing property values. <u>Adverse Effects</u> Flood plain land no longer available for residential, commercial or industrial use. Prices of buildable land may go up which may adversely effect industrial and commercial activity. \$2,000 per year for regional operation and management costs of program.	Program will help maintain present neighborhood character in vicinity of flood hazard areas. Remaining uplands will be subject to accelerated neighborhood change. Present landowners may face loss of property value due to program. Provides an equitable distribution of flood hazard risks.
<u>2-2 Implement structural measures. A program of structural measures is economically feasible in the following subwatersheds:</u> ME-15, ME-19, CO-17, BL-64, TH-1A, SU-17, and NA-10.	<u>Beneficial Effects</u> Average annual flood damage will be reduced by \$373,600. <u>Adverse Effects</u> Average annual cost is estimated to be \$75,400.1/	<u>Beneficial or Adverse Effects</u> Irreversible commitment of land for program measures. Streams altered for project measures.	<u>Beneficial Effects</u> Developed land no longer subject to flooding from 100-year storm. Average annual damage will be reduced by \$373,600. Creates 27 man years semi-skilled employment. <u>Adverse Effects</u> Local average annual cost is estimated to be \$8,300.	<u>Beneficial or Adverse Effects</u> Reduce health and safety hazards associated with flooding. Psychological satisfaction from the action. Some landowners may be adverse to the action. Creates 27 man years semi-skilled employment.

1/ Discount estimated evaluation period.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>2-Flooding - cont.</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
2-3 Implement floodproofing measures.	Average annual flood damage will be reduced by \$587,600.	May adversely effect appearance of some existing structures.	Average annual damage will be reduced by \$587,600.	Reduces health and safety hazards associated with flooding.
A program of floodproofing existing structures is economically feasible in the following sub-watersheds: ME-15, ME-19, CO-17, BL-61, BL-63, BL-64, TH-1A, SU-17, NA-7, NA-8, NA-10, and NA-11.	<u>Adverse Effects</u> Average annual cost is estimated to be \$134,000.		Will create 40 man years semi-skilled employment. <u>Adverse Effects</u> Local average annual cost is estimated to be \$120,000.	Psychological satisfaction from the action. Some landowners may be adverse to the action. Will create 40 man years semi-skilled employment.
<u>2-4 Implement both structural measures and flood proofing.</u>	<u>Beneficial Effects</u> Average annual damage will be reduced by \$529,000.	<u>Beneficial or Adverse Effects</u> Irreversible or irretrievable commitment of land for program measures.	<u>Beneficial Effects</u> Average annual damage will be reduced by \$529,000.	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action.
A program combining structural measures with floodproofing is economically feasible in the following subwatersheds: ME-15, ME-19, CO-17, TH-1A, SU-17.	<u>Adverse Effects</u> Average annual cost is estimated to be \$111,700.	Stream channel altered for project measures. May adversely effect the appearance of some existing structures.	Developed land no longer subject to flooding from 100-year storm. Will create 37 man year semi-skilled labor. <u>Adverse Effects</u> Local average annual cost is estimated to be \$78,200.	Some landowners may be adverse to the action. Will create 37 man years semi-skilled labor. Reduces health and safety hazards associated with flooding.
<u>3-Erosion & Sediment</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
3-1 Establish erosion and sediment control ordinances in municipalities with the most potential for urban development.	18,000 tons/yr. sediment damage reduction. <u>Adverse Effects</u> \$55,000 initial capital cost to initiate program. One and one-half man years to manage program.	Reduce erosion on 6,000 acres/year of construction sites. Eliminate 18,000 tons/yr. of construction site produced sediment. Improvement of water quality downstream.		Will increase cost of developing land for urban purposes.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>3-Erosion & Sediment - cont.</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
3-2 Establish program by SCS aimed at eliminating high erosion losses on "problem" farms of region.	Productivity of farmland is maintained. \$24,000 per year sediment damage reduction.	Reduce erosion on 2,500 acres of tilled cropland. Eliminate 4,000 tons/year of sediment from these sources.	Reduce average annual sediment damages by \$24,000.	Create one professional job per year. Psychological satisfaction from the action.
Inventory, conservation measures and follow up procedure.	<u>Adverse Effects</u> \$20,000/yr. cost of program.	Improve stream water quality.	<u>Adverse Effects</u>	
<u>3-3 Establish and maintain stream buffer zones, forest and other permanent vegetative cover within 50 feet of the region's rivers and streams.</u>	<u>Beneficial Effects</u> Action results in slowing down of stream-bank erosion and subsequent sedimentation.	<u>Beneficial or Adverse Effects</u> Reduce erosion on 80 bank miles and thereby reduce subsequent sedimentation. Establish permanent vegetation on approximately 1,000 acres. Maintain permanent vegetation along additional 230 miles of rivers and streams. Improve stream water quality. Improve quality of fish and wildlife habitat.	<u>Beneficial Effects</u> May increase the supply of recreation activity days in the region. <u>Adverse Effects</u>	<u>Beneficial or Adverse Effects</u> Some landowners may be dissatisfied with reduction in cropland acreage. Psychological satisfaction from the action.
<u>4-Wetlands</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
4-1 An accelerated acquisition program to acquire an additional 8,000 acres (7,700 acres are expected to be acquired under ongoing programs) of regionally important wetlands.	Will contribute to meeting recreational and educational needs. Tends to maintain recreational quality of 8,000 acres. <u>Adverse Effects</u> Average annual cost is estimated to be \$336,000.	Will tend to preserve existing wildlife habitat. May preserve environmentally unique and valuable areas. Irreversible commitment of 8,000 acres prevented. Tends to maintain existing water quality. Tends to maintain low flow regime.	Will contribute to meeting recreational and educational needs of region. <u>Adverse Effects</u> Average annual cost is estimated to be \$336,000. Prices of buildable land may increase and adversely effect economic activity. Decrease property tax base. Initial capital cost is estimated to be \$5,600,000.	Psychological satisfaction from the action. Some resource owners may be adverse to the action.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
4-Wetlands - cont.				
4-2 Accelerate Inland Wetland Restriction Program.	<u>Beneficial Effects</u> Will contribute to meeting recreational needs. <u>Adverse Effects</u> Annual cost is estimated to be \$250,000.	<u>Beneficial or Adverse Effects</u> May lead to preservation of environmentally unique and valuable areas. Will tend to preserve existing wildlife habitat. Tends to maintain existing water quality.	<u>Beneficial Effects</u> <u>Adverse Effects</u> Annual cost is estimated to be \$250,000.	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action. Some resource owners may be adverse to the action.
4-3 Expand special regulations for wetland areas such as, Conservancy Zoning.	<u>Beneficial Effects</u> Discourages improper land use of wetlands.	<u>Beneficial or Adverse Effects</u> Will tend to preserve existing wildlife habitat. May preserve environmentally unique and valuable areas. Irreversible commitment of 4,590 acres prevented. Tends to maintain existing water quality Tends to maintain low flow regime.	<u>Beneficial Effects</u> <u>Adverse Effects</u> Initial capital cost is estimated to be \$50,000. Prices of buildable land may increase and adversely effect economic activity. Decrease property tax base.	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action. Some resource owners may be adverse to the action.
5-Water Supply				
5-1 Investigate potential surface water reservoir sites for use as municipal water supplies.	<u>Beneficial Effects</u> <u>Adverse Effects</u> Cost of investigations.	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u> More fully evaluates the potential of these reservoir sites.	<u>Beneficial or Adverse Effects</u> Provides community with sound data upon which to base future planning.
5-2 Acquire or otherwise protect suitable potential surface water reservoir sites.	<u>Beneficial Effects</u> Potential reservoir site is available when needed to provide water for economic growth. <u>Adverse Effects</u> Cost of land purchase or easements.	<u>Beneficial or Adverse Effects</u> Present land use is maintained. Future land use may change to open water.	<u>Beneficial Effects</u> Potential reservoir site is available when needed to provide for regional economic growth.	<u>Beneficial or Adverse Effects</u> Assures water supply for future needs.

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (Eq)	Regional Development (RD)	Social Well-Being (SW-B)
<u>6-Water Quality</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
6-1 Obtain detailed soil surveys and use them to aid in guiding growth in the following communities:	Assists in determining least cost alternatives to solving water quality problems.	Provides tool for maintaining present quality of all water and related land resources.	Will create 6 man years employment for a professional soil scientist.	Psychological satisfaction from the action.
Carlisle	<u>Adverse Effects</u>		<u>Adverse Effects</u>	Provides basis for determining public health problems associated with water quality.
Dunstable	Initial cost is estimated to be \$150,000:		Initial cost to towns within the region is estimated to be \$110,000.	
Groton				
Lunenburg				
Lancaster				
<u>7-Recreation</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
7-1 Provide 300 additional campsites within the region.	Will provide an additional 69,000 activity days or \$138,000 in recreation benefits annually.	Provides opportunity to modify landscape quality.	Will create 2 permanent semi-skilled jobs.	Will provide 69,000 activity days for recreational opportunities.
	<u>Adverse Effects</u>	Creation of 40 acres of camping facilities.	Will create 4 semi-skilled jobs for 1 year.	Will create 2.5 permanent semi-skilled jobs.
	Average annual cost including O, M & R of about \$105,000.	Modify 40 acres of forest-land by clearing openings for tent sites access and other facilities.	Will create approximately 28,000 activity days or \$56,000 in recreation benefits annually to those within the region.	Will create 4 semi-skilled jobs for 1 year.
	Loss of potential timber harvest on 40 acres of woodland.	May reduce quality of wildlife habitat on approximately 40 acres.	May attract recreation oriented firms.	Provides for a more equitable distribution of recreational resources.
		<u>Adverse Effects</u>		Will create seasonal population influx.
		Loss of potential timber harvest on 40 acres of woodland.		Psychological satisfaction from the action.

ALTERNATIVE ACCOUNTS DISPLAY

TABLE 8.5 - cont.

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
7-Recreation - cont.				
7-2 Provide an additional 10,350 picnic tables.	<p><u>Beneficial Effects</u></p> <p>Provides an additional 1,000,075 activity days or about \$2,000,150 in recreation benefits annually.</p> <p><u>Adverse Effects</u></p> <p>Average annual cost including O, M & R of about \$980,000.</p>	<p><u>Beneficial or Adverse Effects</u></p> <p>Provides opportunity to maintain or increase landscape quality.</p> <p>Creation of 350 acres of picnic facilities.</p> <p>Modifies 350 acres of forestland by clearing for picnic sites.</p> <p>May reduce quality of wildlife habitat on approximately 350 acres.</p>	<p><u>Beneficial Effects</u></p> <p>Will create 2 permanent semi-skilled jobs.</p> <p>Will create approximately 406,000 activity days or about \$812,000 in recreation benefits annually to those within the region.</p> <p>May attract recreation oriented firms.</p> <p><u>Adverse Effects</u></p> <p>Loss of potential timber harvest on 350 acres of woodland.</p>	<p><u>Beneficial or Adverse Effects</u></p> <p>Will provide 1,000,075 activity days for recreational opportunities.</p> <p>Will create 14 permanent semi-skilled jobs.</p> <p>Provides for more equitable distribution of recreation resources.</p> <p>Will create seasonal population influx.</p> <p>Psychological satisfaction from the action.</p>
7-3 Provide hiking trails within proposed greenbelts for the 5 major rivers. Approximately 100 miles of trail.	<p><u>Beneficial Effects</u></p> <p>Provide passive recreation opportunities.</p> <p><u>Adverse Effects</u></p> <p>Costs \$500,000.</p>	<p><u>Beneficial or Adverse Effects</u></p> <p>Increases management of natural and developed areas for human enjoyment.</p>	<p><u>Beneficial Effects</u></p>	<p><u>Beneficial or Adverse Effects</u></p> <p>Psychological satisfaction from the action.</p> <p>Some landowners may be adverse to the action.</p>
7-4 Acquire 6 natural areas (as identified by Natural Area Survey) by quasi-public or public agency.	<p><u>Beneficial Effects</u></p> <p>Preservation of unique natural areas will help maintain attractiveness of region for tourists and other recreation users.</p> <p><u>Adverse Effects</u></p> <p>Annual operation budget for program of \$10,000.</p> <p>Costs involved in implementing program.</p>	<p><u>Beneficial or Adverse Effects</u></p> <p>Preservation of unique natural areas would be monitored by region residents. This will contribute to preservation of those areas not considered "safe indefinitely."</p>	<p><u>Beneficial Effects</u></p> <p>Creates 5 skilled temporary part-time jobs.</p> <p>Economic value to the region of each area would be identified.</p> <p>Maintain attraction of area for tourists and other recreation use.</p> <p><u>Adverse Effects</u></p> <p>Recommendations made may preclude commercial, industrial, or residential development in certain areas.</p>	<p><u>Beneficial or Adverse Effects</u></p> <p>Action would increase public awareness.</p> <p>Psychological satisfaction from the action.</p> <p>Landowners may be adverse to some recommendations.</p> <p>Create 5 skilled temporary part-time jobs.</p>

TABLE 8.5 - cont.

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>7-Recreation - cont.</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
7-5 Implement the Massachusetts Scenic & Recreational Rivers Act within the region.	Positive step in initiating future alternatives of economic significance. <u>Adverse Effects</u> Average annual cost of administering and enforcing the program is estimated to be \$3,000.	Maintains present water quality. Insures preservation of stream character. Positive step in initiating future environmental alternatives.	Provides 1 skilled temporary part-time job. <u>Adverse Effects</u> Price of buildable land may go up which may adversely effect industrial and commercial activity.	Psychological satisfaction from the action. Some landowners may be adverse to the action. Provides 1 skilled temporary part-time job.
7-6 Establish greenbelt programs (similar to the Nashua River Greenway Program) on 4 additional rivers: Merrimack, Concord and tributaries; Blackstone, and Quinebaug Rivers.	<u>Beneficial Effects</u> Provides additional activity days of recreation. Prevents increase in flood damageable properties. <u>Adverse Effects</u> Cost incurred to carry out the program.	<u>Beneficial or Adverse Effects</u> Maintains present water quality. Insures preservation of stream character.	<u>Beneficial Effects</u> Provides additional jobs. <u>Adverse Effects</u> Price of buildable land may go up which may adversely effect industrial and commercial activity.	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action. Some landowners may be adverse to the action. Provides additional jobs.

TABLE 8.6

POTENTIAL ENVIRONMENTAL IMPACTS OF ALTERNATIVES

SIGNIFICANT ENVIRONMENTAL IMPACTS ON: 1/																	
ALTERNATIVES	Erosion & Sedimentation	Water Table Changes	Changes Flow Regime	Changes Land Use	Upland Wildlife Habitat	Bottomland Wetland Habitat	Bottomland Hardwoods	Stream Fisheries	Wetlands	Rare or Endangered Animals, Plants	Intermittent Streams	Perennial Streams	Water Quantity	Water Quality Incl. Receiving Water	Appearance of the Landscape	Irreversible & Irretrievable Commitment of Resources 2/	
																Resources	2/
1.1 Ignore loss of agricultural land	•	•	•	0	-	-	•	0	•	•	•	•	0	0	-	+	
1.2 Preserve agricultural land	0	•	•	+	+	•	•	•	•	•	•	•	0	0	+	+	
1.3 Increase forest management	0	•	•	•	•	•	•	•	•	•	•	•	0	0	0	+	
1.4 Increase forest util. & mgt. incentives	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	+	
1.5 Develop markets for forest products	0	•	•	•	•	•	•	•	•	•	•	•	•	•	0	+	
1.6 Estab. forestry info & education program	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	+	
2.1 Participation in Flood Insurance Program	+	•	+	+	•	+	+	+	+	•	•	+	•	+	0	+	
2.2 Structural flood protection	0	0	0	0	0	0	0	-	0	•	•	-	0	0	0	-	
2.3 Floodproofing and nonstructural	•	•	•	•	•	•	•	•	0	•	•	-	•	0	0	-	
2.4 Structural and floodproofing	0	0	0	0	0	0	0	-	0	•	•	-	0	0	0	-	
3.1 Erosion & sediment control ordinances	+	•	•	•	+	+	+	+	+	•	+	+	•	+	+	+	
3.2 Stream buffer zone	+	0	0	+	•	0	+	+	+	•	•	+	•	+	0	+	
3.3 Cropland erosion program	+	•	•	•	•	•	•	•	•	•	•	•	•	+	•	+	
4.1 Wetlands acquisition	•	+	+	+	+	+	+	+	+	+	+	+	•	+	+	+	
4.2 Expand wetland zoning	•	+	+	+	+	+	+	+	+	+	+	+	•	+	+	+	
4.3 Accelerate Inland Wetland Restriction Pro.	•	+	+	+	+	+	+	+	+	+	+	+	•	+	+	+	
5.1 Investigate potential water supplies	•	•	•	•	•	•	•	•	•	•	•	•	+	•	+	+	
5.2 Acquire or protect water supply sites	•	•	•	•	•	•	•	•	•	•	•	•	+	+	+	+	
6.1 Complete soil surveys	+	+	•	+	+	+	+	+	+	•	+	+	•	+	+	+	
7.1 Provide additional campsites	-	•	•	0	-	-	•	0	•	0	•	•	•	-	+	+	
7.2 Provide additional picnic tables	-	•	•	0	-	-	•	0	•	0	•	•	•	-	0	+	
7.3 Provide additional hiking trails	-	•	0	0	-	-	•	0	•	0	+	•	•	-	+	+	
7.4 Natural areas acquisition	+	•	•	+	+	+	+	+	+	+	+	+	•	+	•	+	
7.5 Massachusetts Scenic Recreation Rivers Act	+	+	+	+	•	+	+	+	+	•	•	+	•	+	+	+	
7.6 Establish greenbelts	+	•	•	+	•	+	+	•	+	+	•	+	•	0	+	+	

1/ (+) Maintains or improves present situation. (-) Adverse impact expected. (0) Could have adverse and/or favorable impact. (•) No significant impact is expected.

2/ (+) No irreversible or irretrievable commitment of resources. (-) Involves an irreversible and irretrievable commitment of resources.

CHAPTER 9

PROGRAM IMPLEMENTATION OF ALTERNATIVES

9.1 INTRODUCTION

This chapter identifies program opportunities available for implementing the alternatives identified in Chapter 8. Existing federal, state, and local programs are outlined, which will enable the alternatives to result in action. The ultimate result of the Massachusetts Water Resources Study is hopefully not a mere list of alternatives to meet needs but, rather, a catalyst for action designed to meet those needs.

9.2 OPPORTUNITIES FOR USDA PROGRAMS

Programs of agencies which are active or may be established in the region will be discussed. Ongoing programs should receive first priority when considering implementation of alternatives. New programs may require a number of years to get them set up and in operation. Table 9.1 summarizes programs and agencies applicable to the various alternatives. Programs are listed under the principal agency responsible for their administration.

9.2A Soil Conservation Service Programs

Conservation Operations Program -- This is the ongoing program of the Soil Conservation Service. Technical assistance is available through the county conservation districts for the planning and installation of measures to develop and conserve natural resources. Field offices located in Acton and Holden provide this technical assistance in the Central Region.

Assistance is available to local communities in the development of Erosion and Sediment Control Ordinances (Alternative 3-1). Sample bylaws have been developed by the National Association of Conservation Districts and governmental research agencies. Communities can also utilize the ordinances of nearby communities for guidance. Personnel from the Soil Conservation Service can assist towns in recognizing the special erosion

and resource management needs of their particular community. This service is also available to individuals and groups within communities.

Technical assistance is available to the conservation districts in preparing the Inventory of Cropland with Serious Erosion Problems (Alternative 3-3). Technical assistance is also available to landowners desiring to reduce erosion losses through the utilization of conservation practices.

Soil Survey Program -- Soil Surveys conducted by the Soil Conservation Service include the mapping, classification, correlation, and interpretation of soils according to national standards. Soil mapping has been completed for much of the Central Region (See Figure 5-17). Communities may accelerate the completion of mapping by sharing the cost of soil surveys within the town boundaries. The soil survey program of the Soil Conservation Service can be used to implement Alternatives 1-2, 5-1, and 6-1.

Soil surveys are an essential element of basic data for the identification of prime agricultural land, and are a first step in any program to protect prime agricultural land from urban development. Alternative 1-2, Preserve Agricultural Land, will rely on accurate soil survey data being available.

Public Law 83-566 -- The Small Watershed Protection and Flood Prevention Act provides technical and financial assistance to solve land and water problems. Flood prevention must be a major concern in each watershed. This Act can be used to implement Alternatives 2-2, 2-4, and 5-1, and assist with Alternatives 7-1, 7-2, and 7-3.

Federal cost sharing is available to provide 100 percent of the cost of structural measures to provide flood protection, and 50 percent of the cost of multipurpose reservoir storage allocated to recreation or fish and wildlife developments. Non PL-566 cost sharing must be provided by local sponsors who must also provide all necessary land rights needed for project installation.

At the present time, federal cost sharing for nonstructural or flood-proofing methods of reducing flood damage is not available under PL-566 or other federal flood protection programs. PL-566 can, however, assist local communities to develop plans for nonstructural flood protection, if this is the most feasible and acceptable alternative. All installation costs must be borne by non PL-566 funds.

The structural measures studied for each watershed with significant damage predominantly include the use of floodwalls or earthen dikes to provide flood protection to an industry or business that sustains major damage. In many cases, residential damage remains, since there is no feasible system of protecting this property in most of the watersheds. Reservoir sites have been encroached upon or have been completely developed with buildings. In other cases, the flat topography limits the number of potential flood prevention sites. In the areas with a large percentage of upstream wetlands, peak flood flows are often below the minimum release rates required for design of a floodwater retarding structure.

Water development projects or local flood control measures should not be carried out under Public Law 83-566 when federal assistance can be provided under more appropriate authorities. This is the case for many of the strictly structural alternatives which protect the major damage area, usually an industry located along the banks of the river. PL-566 can, however, be utilized to plan and implement projects and local protection measures combined with other water resource development, where other authorities are less appropriate.

Massachusetts Natural Resources Planning Program (MNRPP) -- This local initiative program enables communities to inventory their natural resources, to rate those resources against standards, and to determine the consequences

of proposed actions on the natural resource base. A Regional Technical Team is available to assist the townspeople to assess their resources and problems. Graduate student interns work with local residents to collect and analyze data.

The Massachusetts Natural Resources Planning Program is a useful tool in assessing the magnitude of resource problems and in developing courses of action to solve the problems. Preservation of Agricultural Land (Alternative 1-2), Critical Area Inventories (Alternative 3-3), Wetlands Acquisition (Alternative 4-1), Conservancy Zoning (Alternative 4-2) and Wetlands Restriction (Alternative 4-3) should all be more easily implementable in a town participating in the Massachusetts Natural Resources Planning Program. Basic inventories needed for the program, and the increased public awareness of the natural resource base will be useful in laying the foundations for implementation of alternatives.

Resource Conservation and Development Program (RC&D) -- Within Massachusetts, two RC&D areas have been established. These are The Pilgrim RC&D Area, which includes Bristol, Plymouth, Dukes, Barnstable, and Nantucket Counties, and the Berkshire-Franklin RC&D, which includes Berkshire and Franklin Counties. Both of these RC&D areas are entirely outside of the Central Region.

A RC&D area if established in the region, could serve as a vehicle for implementing many alternatives, such as Structural Flood Protection and other measures where social or economic benefits to the area will result. Up to 100 percent federal cost sharing for technical assistance and structural measures for flood control is available. Local sponsors must provide all necessary land rights.

A RC&D area could also assist in implementing Alternative 1-5, Establish a Program to develop diversified markets for forest products, and other forestry alternatives.

9.2B Forest Service Programs

Renewable Resources Program -- This is an "umbrella" program which combines many of the Forest Service authorities into a unified group of systems for recreation, wildlife, timber, land and water conservation, and human and community development. The Forest Service cooperates with the Massachusetts Department of Environmental Management, Division of Forests and Parks, to conduct forestry programs on state and privately owned forestland.

The Renewable Resources Program can provide assistance to forest landowners to Increase Management of Public and Private Forest Land (Alternative 1-3), assist in establishing a Program to Develop Diversified Markets for Forest Products (Alternative 1-5), and to assist in the establishment of an Information and Education Program to Inform Landowners About Benefits of Forest Management (Alternative 1-6).

9.2C Farmers Home Administration Loans and Grants

The FmHA has a number of loan and grant programs designed to encourage the economic development of rural areas. These programs can be used by the region's rural communities to help implement alternatives.

Loans are available to assist sponsoring public agencies in Resource Conservation and Development Areas. Soil and water loans are designed to aid farm landowners to make better use of their farmland. Watershed Protection and Flood Prevention loans help PL-566 sponsors to provide the local cost of structural measures. In addition, loans and grants are available to improve rural water systems.

Farmers Home Administration loans and grants could assist in implementing Alternatives 1-1, 2-2, 2-4, 3-3, and 5-2.

9.2D Agricultural Stabilization and Conservation Service (ASCS)

Agricultural Conservation Program (ACP) -- This program places increased emphasis on rural pollution abatement, as well as: (1) providing incentives for landowners to carry out soil and water conservation practices where benefits in relation to costs are long deferred or that provide significant offsite benefits; (2) encouraging farmers and ranchers to carry out whole-farm long-term conservation plans that emphasize conservation benefits of national concern and aid in preventing pollution of air, soil and water. ACP will provide both technical and financial assistance to farmers whose land is a source of agricultural pollution or affected by wind or water erosion. Cost sharing generally ranges from 50 to 75 percent but can range up to 90 percent on critical problem areas where priorities have been developed by local committees. This program can aid in implementation of Alternative 3-2 and 3-3 to reducing erosion and sediment.

Forestry Incentives Program (FIP) -- This is a production oriented program which provides federal cost sharing on tree planting and timber stand improvement to private landowners. Emphasis is placed upon:

1. increasing the future supply of softwood sawtimber;
2. continued sustained yield, multi-purpose management of private nonindustrial forestland;
3. cost-effectiveness of forest improvement practices as measured by a continuing evaluation.

Cost sharing ranges from 50 to 75 percent. This program can aid in implementation of Alternatives 1-2, 1-3, and 1-4 to preserve and improve forestland.

9.3 OPPORTUNITIES FOR OTHER PROGRAMS

Information on other federal assistance programs exists in the current "Catalog of Federal Domestic Assistance," Executive Office of the President, Office of Management and Budget, Washington, D.C.

Some of the federal programs applicable and pertinent to this study are discussed below:

9.3A Federal Programs

National Flood Insurance Program -- The Department of Housing and Urban Development, through the Federal Insurance Administration, provides communities with the opportunity to participate in the National Flood Insurance Program. Flood insurance is available through local agents for residents of towns which qualify for the program. In return for federally subsidized insurance rates, the community must agree to consider flood hazards before approving development and to severely limit development of flood prone areas. All except three of the Central Region communities are enrolled in the flood insurance program which implements Alternative 2-1, Flood Insurance.

Land and Water Conservation Fund -- The Land and Water Conservation Fund administered by the U.S. Department of the Interior, Bureau of Outdoor Recreation provides cost sharing assistance to finance recreation and open space programs. The Fund could assist in implementing Alternatives 4-1, 7-1, 7-2, 7-3, and 7-4.

9.3B State Programs

Forestry Programs -- The Department of Environmental Management, Division of Forests and Parks, cooperates with the U.S. Forest Service to assist forest landowners to make the best use of the forest resource. This program can aid in the implementation of Alternative 1-3, Increased Management of Forest Land, and Alternative 1-6, Information and Education to Inform Forest Landowners of Benefits of Management.

The Forestland Assessment Act, General Laws, Chapter 61, can be used to maintain forestland in the face of rising real estate taxes, thus, helping to implement Alternative 1-4, Increase Incentives to Manage Forest Land.

Wetlands Programs -- The Wetlands Restriction Section of the Department of Environmental Management administers the Wetlands Restriction Act. Increased staff or greater use of outside consultants will be necessary if Alternative 4-3, Accelerate Wetlands Restrictions, is to be accomplished.

The Massachusetts "Wetlands for Wildlife" program of the Division of Fisheries and Game has purchased wetland areas in the region for their wildlife habitat value. This program can be utilized to implement Alternative 4-1, Wetlands Acquisition. The Division of Conservation Services could assist municipalities to acquire and develop outdoor facilities through the Massachusetts Self-Help program.

Recreational Programs -- The Department of Environmental Management, Division of Forests and Parks, is the agency which would be responsible for implementing the Massachusetts Scenic and Recreational Rivers Act (Alternative 7-5). The department has established a pilot program for the North River to gain experience in administering the act.

The Massachusetts Self-Help Program, Chapter 767 of the Acts of 1970 Massachusetts General Laws can assist with acquisition of water supply sites and acquiring conservation lands for future use as water impoundment sites (Alternative 5-2).

Alternative 7-3 Establishment of Canoe Trails, could also be administered under ongoing programs of the Division of Forests and Parks.

Reservoir Programs -- The Division of Water Resources of the Department of Environmental Management has funds available from a bond issue to acquire and protect potential reservoir sites. Funds may be available from this source to investigate and protect potential surface water reservoir sites (Alternatives 5-1 and 5-2).

9.3C Regional Programs

Regional planning agencies are the logical group to assist communities to establish erosion and sediment control ordinances (Alternative 3-1). Technical assistance and guidance is available from the Soil Conservation Service through the local Conservation District. A number of "model" ordinances are available which can be adapted to fit local conditions.

Land Use Programs -- Recently enacted Agricultural Preservation and Restoration Act under Chapter 780 of the Acts of 1977, Massachusetts General Laws, will be administered by the Division of Conservation Services working in cooperation with local Conservation Commissions. Starting with a pilot program, the Act will seek to halt the development of critical farmland through the purchase of development rights (Alternative 1-2).

The Horticultural Land Assessment Act under Chapter 61A of the General Laws can also be used in a multi-faceted approach to encourage the preservation of agricultural land use.

IMPLEMENTATION OF ALTERNATIVES BY PROGRAM AND AGENCY
(Indicated by x)

9-10

CENTRAL REGION

APPENDIX A

Prime Potential Reservoir Sites

1. Summary

The potential reservoir sites which are presented in this appendix represent the prime possibilities for permanent water storage sites in the Coastal Region which are not already under active consideration for development. Topography, geology, and affected man-made facilities appear to be favorable. More detailed geologic and engineering investigations need to be made before sites are acquired. If future needs for a reservoir site in a particular area can be identified, steps should be taken to acquire the site at an early date so that development in the area does not make reservoir costs excessive. Early acquisition or protection of these potential reservoir sites is essential to conserve these important natural resources for future use.

2. Previous Studies

The Soil Conservation Service has completed and published inventories of potential reservoir sites in the Central Region. Reservoir locations were selected on the basis of suitable topography, relatively undeveloped pool areas, and certain drainage area, pool area, and storage characteristics. Inventory data which was prepared included a surficial geologic investigation, list of man-made facilities which would be inundated and preliminary designs and cost estimates for various levels of development.

The inventories provide a valuable source of basic information about more than 395 potential reservoir sites in the region. No attempt was made in the inventories to evaluate the potential of the sites for specific purposes such as water supply, recreation, etc. Unfortunately, many of the sites which first appear promising fail to meet the more stringent criteria required for a good water supply or low-flow augmentation reservoir. Among the more common problems are poor geologic conditions, recent development of the pool area, and extremely high cost.

3. Site Evaluation

The purpose of this appendix is the presentation of the most promising potential reservoir sites in the Central Region. Inventories of potential sites for the Merrimack, Assabet, Concord, Sudbury, Nashua, Blackstone, and Thames Study Areas were used as the source of basic data. Many sites were quickly eliminated from further consideration because of obvious problems

connected with geologic conditions and extensive effects on man-made facilities. The relatively flat topography in the region also eliminated many sites; large shallow areas tend to produce poorer quality water supply than deep sites. Likewise, low-flow augmentation and recreation uses tend to favor the deeper pools.

The remaining sites were individually evaluated for potential uses. Table A-1 summarizes information for the sites which appear to have potential for permanent storage of water. More detailed information concerning the individual sites is available in the Inventory of Potential and Existing Reservoir Sites for the particular area.

4. Protection of Sites

These potential reservoir sites are an important natural resource. They are examples of unique situations combining suitable topography to provide efficient storage, good geologic conditions which limit excessive seepage losses, and relatively undeveloped, lower cost, reservoir areas. Many of the potential reservoir sites in Massachusetts have been lost for future utilization through poor or uninformed land use decisions. Residential and commercial development in the state has encroached on the potential reservoir area of a number of otherwise suitable sites. In many instances, wetland protection measures have been effective in preserving the stream and the adjoining wetlands. However, the higher nonwetland areas which would be needed to provide deep water storage potential have been subject to development with little restriction. As a result, a potential deep water storage site with good geology may be economically infeasible because of the high cost involved in removing encroaching development.

State and local governments must begin to recognize the importance of protecting this dwindling natural resource--the natural potential reservoir site--from loss through default. The result of inaction in this area will not be catastrophic. Loss of a potential reservoir site is a more subtle loss which may not become apparent for several years until needs for water supply or water-based recreation cannot be easily or economically met. Then it will become apparent that preservation of these sites would have been in the public interest. The purchasing of houses in a potential water supply reservoir is socially disruptive to a community as well as being highly expensive. Development in a potential recreation or fishing pool area usually represents the loss of the site as costs per surface acre become prohibitive. It would appear to be more prudent to establish a program of early acquisition of potential reservoir sites in order to safeguard the areas from development pressures.

A note of caution is necessary at this point. All of the data which has been prepared for the potential site inventories is based on preliminary data which should be substantiated and reinforced before site acquisition is undertaken. Among the most important items which need to be developed

before acquisition is a detailed subsurface geologic investigation to ascertain the materials which are present. Analyses needs to be made of the potential for seepage into the ground water. Current appraisals of land costs by competent professionals are also needed.

If a future need for the site can be identified; and if the detailed studies show the site to offer practical potential, steps should be undertaken to limit unwise development of the area. Purchase of the site is one possibility. Acquisition of development rights is another. A third possibility might be donation of the land for conservation purposes by public-spirited citizens. Even if acquisition of a potential reservoir area does not appear feasible, governments can take steps to make development compatible with future use of the area. Highway locations can be realigned to skirt reservoir sites. Developers can be encouraged to keep potential pool areas as undeveloped green space to complement the developed areas. Town boards can avoid locating schools, sanitary landfills, and other municipal improvements on potential reservoir areas.

If steps are not taken to protect these potential reservoir sites from unwise or uninformed development, they will likely be too costly to acquire in the future. They will be lost for future reservoir use unless timely action is undertaken to protect and preserve them to meet anticipated needs.

CENTRAL REGION
TABLE A.1 - PRIME POTENTIAL RESERVOIR SITES

SITE No.	LOCATION City/Town	Drainage Area (square miles)	WATER SUPPLY			LOW FLOW AUGMENTATION			RECREATION		
			Pool Elevation Mean Sea Level (feet)	Volume (million gallons)	Yield (million gallons per day)	Pool Elevation - Mean Sea Level (feet)	Volume (acre-feet)	Augmentation Flow for 120 days (c.f.s.)	Pool Elevation - Mean Sea Level (feet)	Area (acres)	
ME-1203	Dunstable	2.0	186	180	0.3	186	540	2.2	186	130	
ME-1309	Tyngsborough	1.4	154	350	0.8	148	600	2.5	154	90	
ME-1503	Dracut	4.2	108	980	2.5	102	1800	7.5	109	270	
ME-1505	Dracut	1.4	125	270	0.7	122	580	2.4	125	90	
ME-1508	Dracut	1.3	135	160	0.3	135	480	2.0	135	90	
ME-1513	Andover	5.8	112	1570	3.9	103	2450	10.3	112	380	
ME-1804	Carlisle	5.9	188	510	1.1	188	1570	6.6	188	380	
ME-2006	Boxford	1.1	94	120	0.2	94	380	1.6	94	70	
ME-2009	Methuen	1.2	156	170	0.4	156	530	2.2	156	80	
ME-2026	Haverhill	1.3	154	190	0.4	154	590	2.5	154	50	
ME-2130	West Newbury	1.4	50	140	0.3	50	440	1.9	50	90	
AS-1712	Northborough	1.4	365	320	0.9	358	640	2.7	365	60	
SU-1706	Hopkinton	4.8	273	890	2.8	270	2070	8.7	273	330	
NA-0101	Ashby	4.7	1093	310	1.6	1093	940	3.9	1093	120	
NA-0102	Ashby	8.7	1033	1690	5.2	1024	3520	14.8	1033	240	
NA-0203	Ashburnham	4.7	953	230	1.3	953	700	2.9	953	60	
NA-0204	Ashburnham	1.3	1068	300	0.8	1062	590	2.5	1068	70	
NA-0205	Ashburnham/Westminster	1.0	979	230	0.7	972	460	1.9	979	40	
NA-0210	Westminster	1.0	1031	230	0.7	1027	430	1.8	1031	70	
NA-0222	Westminster	1.4	964	320	0.9	954	630	2.6	964	40	
NA-0313	Leominster	1.8	764	410	1.2	758	750	3.2	764	90	
NA-0318	Fitchburg	1.2	945	330	0.8	930	530	2.2	945	40	
NA-0703	Harvard	1.0	383	220	0.6	380	400	1.7	379	70	
NA-0709	Harvard	7.5	282	1640	4.7	274	3190	13.4	282	270	
NA-0803	Lunenburg	2.5	365	550	1.6	358	1060	4.5	365	100	
NA-0807	Lunenburg	2.8	361	580	1.7	358	1120	4.7	357	190	
NA-0822	Lunenburg	1.0	485	240	0.7	480	450	1.9	485	60	
NA-0901	Lunenburg	10.1	363	760	3.6	363	2320	9.8	363	390	
NA-0904	Shirley	1.0	321	150	0.5	321	470	2.0	321	50	
NA-0907	Lunenburg	5.2	428	760	2.7	428	2350	9.9	428	190	
NA-1001	Ashby	1.7	865	390	1.1	859	720	3.0	865	90	
NA-1005	Ashby	3.8	757	550	2.0	757	1680	7.0	757	120	
NA-1020	Ashby	2.9	683	560	1.7	678	1260	5.3	683	110	
NA-1104	Pepperell	1.9	308	490	1.3	301	790	3.3	308	120	

CENTRAL REGION
TABLE A.1 - PRIME POTENTIAL RESERVOIR SITES

SITE No.	LOCATION City/Town	Drainage Area (square miles)	WATER SUPPLY			LOW FLOW AUGMENTATION			RECREATION		
			Pool Elevation Mean Sea Level (feet)	Volume (million gallons)	Yield (million gallons per day)	Pool Elevation - Mean Sea Level (feet)	Volume (acre-feet)	Augmentation Flow for 120 days (c.f.s.)	Pool Elevation - Mean Sea Level (feet)	Area (acres)	
BL-6106	Millbury	4.7	563	1010	2.9	556	1990	8.4	563	200	
BL-6206	Grafton	1.3	374	300	0.8	369	580	2.4	374	80	
BL-6212	Sutton	2.0	550	450	1.3	543	850	3.6	550	90	
BL-6401	Douglas	1.0	653	230	0.6	646	450	1.9	653	50	
BL-6404	Douglas	1.4	551	320	0.9	544	620	2.6	551	60	
BL-6405	Douglas	2.1	517	450	1.3	512	850	3.6	517	130	
BL-6416	Uxbridge	1.3	433	130	0.6	433	410	1.7	433	60	
BL-6502	Northbridge	4.7	390	1040	3.0	385	2160	9.1	390	210	
BL-6503	Sutton	1.2	542	280	0.8	532	520	2.2	542	40	
BL-6508	Sutton	2.6	519	580	1.6	511	1130	4.7	519	90	
BL-6514	Douglas	2.7	683	600	1.7	674	1180	5.0	683	90	
BL-6516	Uxbridge	2.4	332	540	1.5	326	980	4.1	332	130	
BL-6603	Grafton	1.0	411	190	0.6	409	400	1.7	407	70	
BL-6613	Upton	1.4	357	240	0.8	354	580	2.4	357	70	
BL-6622	Uxbridge	3.1	271	500	1.7	270	1440	6.0	271	90	
BL-6624	Uxbridge	1.2	273	50	0.3	273	150	0.6	273	20	
BL-6625	Uxbridge	1.0	353	70	0.4	353	220	0.9	353	60	
BL-6626	Mendon	2.5	334	390	1.4	332	1050	4.4	334	80	
BL-6701	Mendon	1.8	336	410	1.2	331	780	3.3	336	110	
BL-6702	Mendon	1.1	243	220	0.7	238	480	2.0	243	60	
BL-6703	Blackstone	1.9	273	320	1.1	270	800	3.4	273	80	
BL-6704	Mendon	3.6	246	660	2.1	242	1470	6.2	246	170	
BL-6705	Milford	4.9	343	570	2.2	343	1760	7.4	343	210	
BL-6804	Wrenham	4.6	250	900	2.7	248	1870	7.5	246	290	
TH-0101	Monson	1.4	746	220	0.8	882	410	1.7	746	50	
TH-0103	Wales	1.0	890	230	0.7				890	50	
TH-1A01	Brimfield	1.2	700	190	0.7	700	590	2.5	700	50	
TH-1A03	Brimfield	1.3	737	210	0.7	737	660	2.8	737	40	
TH-1A04	Warren	1.1	819	190	0.6	816	500	2.1	819	30	

CENTRAL REGION
TABLE A.1 - PRIME POTENTIAL RESERVOIR SITES

SITE No.	LOCATION City/Town	Drainage Area (square miles)	WATER SUPPLY			LOW FLOW AUGMENTATION			RECREATION		
			Pool Elevation Mean Sea Level (feet)	Volume (million gallons)	Yield (million gallons per day)	Pool Elevation - Mean Sea Level (feet)	Volume (acre-feet)	Augmentation Flow for 120 days (c.f.s.)	Pool Elevation - Mean Sea Level (feet)	Area (acres)	
TH-1A12	Charlton	2.3	717	220	1.0	717	670	2.8	717	155	
TH-1A14	Charlton	1.0	782	110	0.5	782	350	1.5	782	70	
TH-1A17	Charlton	1.3	648	240	0.8	644	490	2.1	652	80	
TH-1A21	Charlton/ Sturbridge	6.5	634	1390	4.4	626	2810	11.8	634	190	
TH-1A22	Charlton	5.8	604	610	2.8	604	1830	7.9	604	140	
TH-1A25	Dudley	1.4	519	260	0.9	516	670	2.8	527	50	
TH-1A28	Southbridge	9.4	535	790	4.2	535	2430	10.2	535	120	
TH-1A33	Holland	1.7	692	270	1.0	690	720	3.0	702	80	
TH-1A34	Holland	1.8	777	360	1.2	773	810	3.4	777	90	
TH-1A37	Holland	2.5	918	440	1.5	917	1180	5.0	918	140	
TH-1A38	Brimfield	1.7	725	90	0.5	725	280	1.2	725	110	
TH-0206	Oxford	1.7	644	150	0.7	644	470	2.0	644	110	
TH-0209	Charlton	2.5	665	390	1.4	665	1180	5.0	665	90	
TH-0211	Charlton	3.9	655	760	2.5	652	1590	6.7	655	250	
TH-0216	Charlton	1.1	798	230	0.7	798	710	3.0	798	70	
TH-0219	Spencer	1.8	879	70	0.4	879	200	0.8	879	120	
TH-0226	Leicester	2.0	946	310	1.1	946	950	4.0	946	60	
TH-0227	Webster	1.8	468	240	0.9	468	730	3.1	468	120	
TH-0236	Leicester	1.3	975	300	0.9	970	600	2.5	975	70	
TH-0255	Douglas	1.0	649	180	0.6	646	430	1.8	654	50	

Levels of development presented in this table were selected to illustrate the maximum potential for each use.

Water supply is based on a safe yield of 0.6 million gallons per day per square mile of drainage area or the maximum safe yield of the site; whichever is less.

Low flow augmentation is based on 8 inches of runoff volume from the drainage area, or the maximum storage available at the site; whichever is less.

Recreation is based on the lesser of: the maximum surface area available at the site, or the surface area which is one-tenth of the drainage area size.

APPENDIX B

This section contains the criteria used to evaluate major wetlands in the Central Region. Each of the 79 wetlands evaluated was subjected to map study and a field examination. Ratings were assigned based on point values obtained for various attributes. Rationale for each evaluation item is also contained in this appendix to explain the background concerning development of the criteria.

The wetland evaluation criteria were developed by an interdisciplinary team of USDA specialists. Draft criteria were circulated among federal, state and regional agencies for comments and suggestions.

The criteria, with modifications, may be helpful in assessing the smaller wetlands of a community. Development of the evaluation procedure was based upon a regional approach and certain criteria, such as size, may need to be altered to fit local situations. The numerical rating values might also need to be modified to account for factors which might be important from a local basis but insignificant on a regional scale.

WETLAND EVALUATION

Wetland Name _____ No. _____ Date _____

Wetland Location (City or Town) _____

Investigator _____

Ownership (Public - give name; or Private) _____

Size (acres) _____ Drainage System _____

Type Classification (acres per type) _____

Surrounding Topography _____

Flora _____

Fauna _____

Current Use _____

Adjacent Land Use _____

Nearness to Houses, etc. _____

Potential Pollution Problem _____

Accessibility _____

Potential Storage Depth at Outlet _____ ft. (vertical distance from normal water level to top of control structure)

Size of outlet structure if any _____

Rating Summary

Forest Management _____ Recreation _____

Flood Control _____ Uniqueness _____

Fish Habitat _____ Visual Quality _____

Wetland Wildlife Habitat _____

Comments

WETLAND EVALUATION

Wetland Name _____ No. _____

FOREST MANAGEMENT 1/

CRITERION	RANGE	Circle Correct RATING
1. Public ownership of forested wetland	>30% 15-30% <15%	3 2 1
2. Stand size class distribution 2/ (sawtimber; poletimber, seedling-sapling)	<80% in any 2 classes >80% in any 2 classes >80% in any 1 class	3 2 1
3. Portion of forestland with 81-100% crown closure	>80% 30-80% <30%	6 4 2
4. Portion of wetland forested	>60% 30-60% <30%	3 2 1
5. Predominant forest cover type	Cedar, red maple, larch/ tamarack or green ash Hemlock, black ash or black spruce	9 3
6. Shape of forested wetland	Block Long narrow strip	3 1
7. Type of soil	Mineral Peat	6 2
8. Accessibility	Roads in wetland Roads leading to but not in wetland No roads leading to wetland	6 4 2
Total circled items: _____		

RATING: Greater than 28 = High
24 to 28 = Moderate
Less than 24 = Low

Rating is: _____

1/Wetlands containing less than 5 acres of forest should not be rated.
Insert NR in rating blank.

2/ If wooded areas are inaccessible for inspection MacConnell's height
classes may be used:

Classes 1 & 2 Seedling-Sapling
Classes 3 & 4 Poletimber

Class 5 Sawtimber
Class 6 - rates high (3)

WETLAND EVALUATION

Wetland Name _____ No. _____

FLOOD CONTROL

CRITERION	RANGE	Circle Correct RATING	
1. Effective storage of wetland on total watershed above.	<1" runoff		0
	1"-3" runoff		6
	>3" runoff		9
2. Effective storage of upstream reservoirs and wetlands on total watershed.	<1" runoff		3
	1"-3" runoff		2
	>3" runoff		1
3. Effective storage on main stem between wetland and Potential Damage Area or major confluence.	<1" runoff		8
	1"-3" runoff		4
	>3" runoff		0
4. Distance downstream to Potential Damage Area	<1 mile		3
	1-5 miles		1
	over 5 miles		0
5. Severity of Potential Flood Damage (downstream)	<3 miles	Low	2
		Moderate	4
		High	8
	or 3-5 miles or below major confluence	Low	1
		Moderate	2
		High	4

Total circled items: _____

RATING: Total is: Less than 15 = Low
15 to 23 = Moderate
24 or greater = High RATING is: _____

WETLAND EVALUATION

Flood Control

Instructions for Each Item on the Evaluation Sheet

1. The effective storage can be estimated by expected increase in wetland water elevation (a) during a large (approx. 100 year) flood times (x) the wetland area times (x) 12 divided by the drainage acres.

$$\text{Effective Storage} = \frac{\text{Change in elevation x wetland area x 12}}{\text{(in inches runoff) drainage acres}}$$

(a) Where there is a control at outlet of wetland, change in elevation will be estimated by field observation. Where there is no control, use attached curves.

2. Effective storage of upstream reservoirs and wetlands is estimated as under Item 1 and includes all storage in the drainage area above the wetland being evaluated, but not the wetland storage.
3. Effective storage on the main stem below the wetland being evaluated and the major part of the damage area. This is the storage of the downstream channel or wetland (inches) divided by the total drainage above the damage area (acres).
4. This is a visual estimate using aerial photos, quad sheets, personal knowledge or observation.
5. This is to be a comparison rating based on aerial photos, quads, personal knowledge and observation. Damage which might occur to that which replaces and surrounds the wetland should also be considered.

Potential Damage: Low - agriculture, scattered residences, secondary roads

Moderate - >low but <high

High - concentrated residences, commercial, industrial, primary roads.

Limitation of Wetland Rating

The following system of evaluating wetlands as to their effectiveness in controlling floodwaters categorizes the wetland as: low, medium or high. No attempt should be made to compare wetlands within a category on the sole basis of the numerical rating.

Procedure for Wetland Evaluations

1. Use one sheet for each wetland.
2. Begin at upper end of drainage and work downstream.
3. The downstream wetland of two wetlands in series should be partially completed before rating the upper wetland.

Wetland or Other Control	Drainage (ac.)	Storage (ac./ft.)	Storage (in.)	Upstream Storage (ac./ft.)	Upstream Storage (in.)	Downstream Storage (ac./ft.)	Downstream Storage (in.)
-----------------------------	-------------------	----------------------	------------------	-------------------------------	---------------------------	---------------------------------	-----------------------------

This table is to be completed on drainages with more than one wetland.
Wetland areas should be listed working downstream.

WETLAND EVALUATION

[illegible]

FISH HABITAT 2/

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Principal wetland type 1/	5	4 (with some type 5 present)	Other
2. Size (acres of Type 5) 1/	50+	>25 but <50	<25
3. Location of wetland	Immediately adjacent to a lake which supports warm water fish.	Immediately adjacent to a perennial stream that supports warm water fish.	Adjacent to intermittent stream or cut off from streams.

Presence of fish cover	Abundant	Limited	Scarce
------------------------	----------	---------	--------

Presence of game fish (number of species present)	2 or more	1	None
--	-----------	---	------

Total number of items circled in (a) (b)

Calculation:

No. circled in column (a) $\times 2$ + no. circled in column (b) $\times 1 =$

RATING: Total is: 8 to 10 = High
 5 to 7 = Moderate
 0 to 4 = Low

RATING IS: _____

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

2/ There must be some type 5 present to evaluate the wetland for this use. If not rated insert NR in rating blank.

WETLAND EVALUATION

Wetland Name _____ No. _____

WETLAND WILDLIFE HABITAT

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Principal wetland type 1/	3 or 4	5, 6 or 7	1, 2 or 8
2. Number of wetland types 1/	3 or more	2	1
3. Diversity of adjacent land use (other than urban types) 2/	3 or more	2	1
4. Percent of perimeter with 300'+ wide buffer strip 3/	80%+	60%+ but <80%	<60%
5. Size (acres)	200 or more	100+ but <200	<100
6. Islands	Yes	---	No
Total number of items circled in:	(a) _____	(b) _____	

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING:

Total is: 9 to 12 = High
5 to 8 = Moderate
0 to 4 = Low

RATING IS: _____

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, United States Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

2/ The following types will qualify for the diversity determination:

1 type - forestland (any or all type(s) present will collectively constitute the equivalent of one diversity type)

1 type - unused tillable (TU), pasture (T), orchard (O)

1 type - abandoned field (AF), abandoned orchard (AO)

1 type - sand or gravel removal (SG) (inactive)

1 type - recreation land--any one or more of the following types:

RG - golf course, RD - golf driving range, RSK - ski area,

RFG - fairground, RP - urban park

3/ Buffer strip = area adjacent to wetland perimeter without occupied buildings or other urban uses.

WETLAND EVALUATION

Wetland Name _____ No. _____

RECREATION

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
<u>BOATING:</u> (Pleasure and Fishing - canoe and flat bottom)			
1. Principal Wetland Type used for boating (4 or 5)	5	4	All others
2. Acres available (per continuous wetland 4 & 5)	100+	>50 but <100	<50
3. Physical Access (No. of Access Points)	2+	1	0
4. Boatable Stream Present	(enters and leaves wetland)	(enters or leaves wetland)	none present

FISHING: (shoreline)

5. Principal Wetland Type used for fishing (4 or 5)	5	4 (with some type 5 present)	other
6. Wetland Size (acres)	50+	>25 but <50	<25
7. Physical Access--shore Percent of shoreline from which fishing is available	20%+	5%+ but <20%	<5%

NATURE STUDY:

8. Diversity of plants and animals (number of types)	3 or more	2	1
9. Percent of urban development within 300 feet of wetland perimeter.	<5%	5% to <25%	25%+

HUNTING:

10. Waterfowl hunting - amount of Type 3, 4 and 5	100 acres+	25+ but <100	<25 acres
11. Access for hunting	Unlimited	Permission of landowner required	None available

Total number of items circled in (a) _____ (b) _____

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING: Total is: 16 to 22 = High
9 to 15 = Moderate
0 to 8 = Low

RATING IS: _____

WETLAND EVALUATION

Wetland Name _____ No. _____

UNIQUENESS

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Location - wetland surrounded by:	Intensely urban	Suburban	Rural
2. Wetland supports a threatened, endangered, or uncommon species of plant or animal	A threatened or endangered species	An uncommon species	None
3. Wetland contains a regionally rare plant community 1/	Yes	--	No
4. Wetland attracts a regionally significant number of migrating birds	Yes	--	No
5. Wetland is archaeologically, geologically or historically significant	Yes	--	No
6. Size: (acres)*	500 acres and more	200 acres or more but < than 500 acres	<200 acres

Total number of items circled in: (a) _____ (b) _____

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING: a. Any item 2-6 rating high = High

b. Total is: 3 to 6 = Moderate
0 to 3 = Low

RATING IS: _____

1/ Occurs less than 5% of the time in inventoried wetlands.

* Uniqueness due to size may need evaluation by region in Massachusetts. The north and southeastern sections of the state have wetland areas qualifying (under for the above categorization; Western and Central Massachusetts should be re-evaluated in terms of overall wetland size.

WETLAND EVALUATION

Wetland Name _____ No. _____

VISUAL QUALITY

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. One or more public roads enables travelers to overlook the wetland at	3+ different locations or 1 mile or more	2 different locations or 1/4 mile+ but <1 mile	1 location or <1/4 mile
2. Overlooks accessible by-path or trail	2 or more overlooks accessible	1 overlook accessible	No overlooks accessible
3. Wetland contains some type of wetland consisting of deciduous woodland	75+ acres of red maple	40+ but <75 of red maple	<40 acres
4. Surrounding topography provides potential for developing overlooks	Potential for 2 or more different overlooks	Potential for 1 overlook	No potential for an overlook
5. Wetland contains an island	Yes	---	No
6. Appearance and condition	Undisturbed and natural	Somewhat disturbed and littered	Messy, littered, filling, junky
7. Wetland types	Wetland contains some visible Type 4 or 5	Wetland contains some Type 2 or 3	Wetland contains no visible Types 2, 3, 4 or 5

Total number of items circled in (a) _____ (b) _____

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING:

Total is: 10 to 14 = High

5 to 9 = Moderate

0 to 4 = Low

RATING IS: _____

Rationale - Forest Management

CRITERION 1 - PUBLIC OWNERSHIP

Publicly owned forestland is more prone to multiple use management which includes wood fiber production as one of the uses.

CRITERION 2 - STAND SIZE CLASS DISTRIBUTION

The optimum size class distribution is 50 percent sawtimber, 25 percent poletimber and 35 percent seedling-sapling. Sawtimber trees are live trees of commercial species that have the following minimum diameters at breast height--softwoods 9.0 inches and hardwoods 11.0 inches. Poletimber trees are live trees of commercial species at least 5.0 inches in diameter at breast height but smaller than sawtimber size. Seedling-sapling trees are live trees of commercial species with diameters at breast height of less than 5.0 inches.

CRITERION 3 - STAND DENSITY

Optimum wood fiber production is achieved when the stand is fully stocked. One measure of stocking is the amount of crown closure. The greater portion of the forest that is at or near full stocking, the higher the potential for wood fiber production.

CRITERION 4 - PORTION OF WETLAND FORESTED

The greater the amount of the wetland forested, the greater the potential for wood fiber production, and the greater the incentive for the landowner to manage the land for forest products.

CRITERION 5 - FOREST COVER TYPE

The forest cover type of any area is determined by the principal species present. Cedar, red maple, larch/tamarack or green ash are the cover types that have the highest value for wood fiber production. Management of these types would be the most profitable.

CRITERION 6 - SHAPE OF FORESTED WETLAND

A block of forestland of some regular shape is more conducive to management than a long narrow strip of forestland, as might be found along a waterway.

CRITERION 7 - TYPE OF SOIL

The volume of wood that can be grown on a site is directly related to the soil. Peat soils generally produce wood fiber at a much slower rate and poorer quality than mineral soils.

CRITERION 8 - ACCESSIBILITY

Forestland that has roads to and through it is more conducive to management because road construction is one of the major expenses of forest management.

Rationale - Flood Control

To evaluate wetlands for their value in flood control three basic factors are considered, these are: (1) the actual storage, (2) the effectiveness of that storage, (3) the existing need for control downstream (damage potential).

1. The effective storage of a wetland in relation to its drainage area is the single most important factor in flood control. As the inches of runoff storage increases, the more significantly are flows extended over a longer period of time, thus reducing the peak flows from any given storm.
2. Effective upstream storage by reservoirs and other wetlands may already be controlling the flows to the extent that the storage in question may have little effect, even though it has a very effective storage volume.
3. Main stem storage upstream of a potential damage area can have the same effect on peak flows as another wetland. Also, small streams entering a large stream generally have a significantly reduced effect on flows below that point.
4. The effect of a wetland decreases as you move downstream from it. This is because of two things, first, the routing effect of the stream channel and flood plain itself and secondly, as you move downstream the drainage area becomes progressively larger and the considered wetland has less effect.
5. The value or importance of a wetland for flood control is reduced if there is little or no potential for damage downstream regardless of how effective it may be.

Rationale - Fish Habitat

Principal Wetland Type - Type 5 is the only freshwater wetland type that can support fish in all seasons. Type 4 is suitable in spring and fall, but some Type 5 must be present to maintain fish during summer and winter.

Size - The larger the wetland the more fish it will physically support. One hundred acres was considered necessary to rate high in a regionwide inventory.

Location of Wetland - Wetlands are often used for spawning habitat by warm water species of fish. Some species of fish (e.g., golden shiner, chain pickerel) require aquatic vegetation for spawning sites. Warm water lake fishery is dependent on wetland acreage for spawning sites, nutrient inflow, and as young fish rearing areas. Perennial streams supporting warm-water fish benefit from wetlands, but generally less so than lakes. Intermittent streams do not support substantial fishery.

Presence of Fish Cover - Warm-water fish require logs, stumps, pond lilies, watershield, etc. for protective cover. If the wetland surface is covered with 35 percent or more with stumps, lilies and other plants, it will have a rating of abundant; 10 percent or more, but less than 35 percent will rate as moderate; less than 10 percent as scarce.

Presence of Game Fish - If the wetland is included in "An Inventory of the Ponds, Lakes and Reservoirs of Massachusetts" by James A. McCann (published by Water Resources Research Center, University of Massachusetts) and has a specified productivity of 60 or more pounds of fish per acre, the rating will be high. If listed productivity is 40 or more, but less than 60, the rating will be moderate. If listed productivity is less than 40 pounds per acre, the rating will be low.

If the wetland is not included in "An Inventory of the Ponds, Lakes, and Reservoirs of Massachusetts," then the rating will be based on the following:

High rating - 2 or more species of game fish are present

Moderate rating - 1 species of game fish is present

Low rating - no species of game fish is present.

Game fish shall be limited to brook trout, brown trout, largemouth bass, chain pickerel, and northern pike.

Rationale - Wetland Wildlife Habitat

These criteria were developed to rate wetlands for wetland wildlife habitat. Species in this category include shorebirds, waterfowl, herons, bittern, beaver, muskrat, otter, and associated songbirds (e.g., yellow warbler, tree swallow, red-winged blackbird, marsh wren, kingfisher, etc.).

Principal Wetland Type - For wetland wildlife Types 3 and 4 ^{1/} were considered the most valuable. In the northeast 3/4 or more of the Type 3 and 4 wetlands are classified of prime importance to waterfowl. These types are also of high value to the other forms of wetland wildlife itemized above. Types 5, 6 and 7, although not providing as great a diversity of plant life, are of moderate value to wetland wildlife.

Types 1, 2 and 8 are either only infrequently wet or support a very limited diversity of plants (bogs).

Although all wetland types provide habitat for certain species of wildlife, the criteria emphasizes those types with permanent water for the wetland wildlife rating.

^{1/} Wetlands of the United States, Circular 39, U.S. Department of the Interior, 1971.

Number of Wetland Types - The greater the number of types in a single wetland the greater will be the diversity of flora and fauna in that wetland. Diversity is a common parameter for measuring quality.

Diversity of Adjacent Land Use - Adjacent land uses provide additional feeding or nesting sites for many of the wetland wildlife species.

Buffer Strip - A 300 foot wide or greater buffer strip without occupied buildings or other intensive uses will serve to protect the amenities of the wetland. Buffer strips provide nesting habitat for many species of wetland wildlife. Seventy-five percent of all duck nests are found within 300 feet of water. Nests are seldom found closer than 100 feet of buildings.

Size - A minimum wetland size was necessary to prevent excessive expenditures of time on the wetland inventory portion of the river basin studies. The minimum size varies in different regions of the state depending upon the number and size of wetlands present. It is the intent of the inventory to include only the more significant wetlands in each region, however, smaller wetlands of regional significance may be included.

Islands - Islands provide a preferred nesting site of the mallard, teal and black duck. Islands offer natural protection from predators reluctant to travel over water to reach the island.

Islands also usually provide a diverse vegetative condition especially when the island elevation exceeds 3 feet above the normal water elevation of the wetland.

Rationale - Recreation

These criteria were developed to rate the value of a wetland for canoe or flat bottom boating, fishing, nature study and hunting. These were considered to be the primary recreation activities conducted on wetlands.

Boating

Principal Wetland Type - Type 5 (inland open Freshwater) consists of open water up to 10 feet deep and because it is deep was rated the best suited for boating use.

Type 4 was rated as moderate value for boating because its depth ranges from only 6 inches to 3 feet and it supports a substantial amount of emergent and floating aquatic plant growth.

All other wetland types were considered unsuitable for boating because of: lack of standing water or dense vegetation.

Acres Available - The more boatable water available, the more desirable the boating activity. Continuous wetland means that the wetland inventoried is either one single wetland or is two or more boatable wetlands linked by a boatable stream.

Physical Access - Physical access means that it is convenient to launch a canoe or flat bottom boat without excessive carrying distances or without having to push the craft out through dense woody vegetation to reach open water.

Boatable Stream Present - Access is facilitated and it is more desirable if a boatable stream enters, crosses and leaves a wetland area.

Fishing

Principal Wetland Type - Type 5 is the only wetland type of sufficient depth to support fish during all seasons. Type 4 will support fish in spring and fall but there is likely to be oxygen deficiencies in summer and winter, therefore, the presence of some Type 5 is essential.

Size - The larger the wetland the more attractive it is for fishing and the more fish will be supported. One hundred acres or more in size was considered necessary to rate high in a regionwide inventory.

Physical Access - Shore - Many persons, particularly children desiring to fish do not have boat equipment and their fishing is limited to the shoreline. Some open shoreline free of woody plants and dense herbaceous plants is necessary for casting.

Nature Study

Diversity of Plants and Animals - Each wetland type supports a variety of wetland flora and fauna. The greater the number of wetland types present in the wetland the greater will be the diversity of flora and fauna. The more diversity present the better will be the nature study opportunities.

Wetland Perimeter - Urban development in the 300 foot wide strip would detract from the nature study values of a wetland (noise, pollutants, litter, domestic animals, trail bikes, etc.).

Hunting

Waterfowl Hunting - Types 3, 4 and 5 are the most attractive wetlands for waterfowl and consequently for waterfowl hunting. Although any size wetlands of these types will attract waterfowl, a 100 acre plus wetland was considered to be significant on a regionwide basis.

Access for Hunting - Hunting is only possible where permitted by the landowner or governing agent.

Rationale - Uniqueness

Location of Wetland - There are few situations where wetlands are located in intensely urbanized areas. Where this is the case, the wetland provides many people with the opportunity to observe or study the diverse flora and fauna within the wetland. Close proximity to schools offers the potential for formal study by school biology and earth science classes.

Threatened, Endangered or Uncommon Species - Science is as yet ignorant of the net results of a species being exterminated and until mankind becomes this sophisticated in his knowledge of the natural environment we had best tread lightly. The diversity of species is an indicator of environmental quality and when the diversity is reduced the environmental quality is likewise reduced. Man is a part of the natural environment and must co-exist with other species in this natural environment.

Migrating Birds - Offers the public an opportunity to see unusual wildlife concentrations.

Archaeologic, Geologic or Historic Significance - This determination will be sought from local, regional and state authorities (e.g. State Historical Society, Regional Planning Authority).

Size - Any wetland greater than 200 acres in size is uncommon in the Commonwealth of Massachusetts.

Rationale - Visual Quality

The visual quality of a wetland is largely dependent upon the wetland's openness and available access from which people can view it. Wetland Types 1/ 2, 3, 4, and 5 are the more open types which people can look at.

Roads around or through a wetland enable people to look out over the wetland even though they don't care to walk into its interior. For those persons wanting to see a wetland, paths or trails facilitate access.

Islands add to the diversity of flora within a wetland and, therefore, contribute to the wetland's visual quality.

Litter detracts from a wetland's appearance and, therefore, absence of litter is a positive factor.

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

APPENDIX C

List of Ponds, Lakes, and Reservoirs
to be furnished by
the
MASSACHUSETTS DIVISION OF WATER RESOURCES

APPENDIX D

List of References



aTC424
.M4M3
v.4

WASHINGTON ADVISORY COMMITTEE DRAFT

MASSACHUSETTS WATER RESOURCES STUDY Δ. Δ. 16

COASTAL REGION REPORT
MASSACHUSETTS

Prepared by
United States Department of Agriculture
and the
Massachusetts Water Resources Commission

JANUARY 1978

Volume 4

NATIONAL

**A
G
R
I
C
U
L
T
U
R
A
L**



LIBRARY

WATER RESOURCES STUDY
REGION REPORT
OF CONTENTS

Page Number

R 1 - SUMMARY

1		1- 1
1		1- 3
		1- 3
		1- 4
		1- 5
		1- 6
	D. Wetlands	1- 6
	E. Water Supply and Irrigation	1- 6
	F. Water Quality	1- 7
	G. Recreation	1- 8
1.3	SUMMARY TABLES	1- 8

CHAPTER 2 - INTRODUCTION

2.1	GENERAL	2- 1
2.2	AUTHORITY FOR USDA AND OTHERS' PARTICIPATION	2- 1
2.3	OBJECTIVES AND NATURE OF STUDY	2- 2
2.4	PLANNING PROCEDURES AND REPORT PRESENTATION	2- 2
2.5	GENERAL DESCRIPTION OF THE STUDY AREA	2- 6
	A. Population	2- 9
	B. Economic Activity	2-10

CHAPTER 3 - PROBLEMS AND OBJECTIVES

3.1	INTRODUCTION - PRINCIPLES AND STANDARDS	3- 1
3.2	PROBLEMS AND OBJECTIVES	3- 3

CHAPTER 4 - ECONOMIC PROJECTIONS AND ENVIRONMENTAL CONSIDERATIONS

4.1	HISTORIC DEVELOPMENT - GENERAL ECONOMIC DEVELOPMENT AND SIGNIFICANT EFFECTS ON THE ENVIRONMENT	4- 1
4.2	SOCIO-ECONOMIC DATA	4- 7
	A. Projections and Relationship to OBERS	4- 7
	B. Employment	4- 7
	C. Income	4-10
	D. Urban Centers and Their Influence	4-10
	E. Transportation	4-11
4.3	AGRICULTURAL AND FOREST RESOURCES AND RELATED ECONOMIC ACTIVITY	4-12
	A. Agriculture	4-12
	B. Forest Resource	4-21
4.4	OTHER SIGNIFICANT ECONOMIC SITUATIONS	4-29
	A. Tourism	4-29
	B. Commercial Fishing	4-32
4.5	RELATIONSHIP BETWEEN ECONOMIC SITUATION AND NED SPECIFIC COMPONENTS	4-33
	A. Study Concern - Land Use	4-33
	B. Study Concern - Inland Floodland	4-34
	C. Study Concern - Wetlands	4-34
	D. Study Concern - Recreation	4-35
4.6	ENVIRONMENTAL SITUATION	4-35
	A. Coastline and Tidewater	4-35
	B. Land	4-37
	C. Population Distribution and Land Use Aspects	4-40
	D. Inland Water	4-45
4.7	PROJECTIONS	4-47
	A. General Methodology	4-47
	B. Population Projections	4-49
	C. Land Use Projections	4-50
	D. Economic Projections	4-55
	E. Wood Products Projections	4-58
	F. Outdoor Recreation Projections	4-58

U. S. DEPT. OF AGRICULTURE
 NATIONAL AGRICULTURAL LIBRARY
 JUN 22 1983
 CATALOGING & PREP.

TABLE OF CONTENTS (Continued)

Page Number

CHAPTER 5 - RESOURCE BASE AND EXISTING PROGRAMS

5.1	GENERAL	5- 1
	A. Soils	5- 4
	B. Geology	5- 9
	C. Vegetative Cover	5-12
	D. Climate	5-12
	E. Storms and Droughts	5-13
5.2	LAND USE	5-18
	A. Agricultural Land	5-18
	B. Agricultural Land Study	5-27
	C. Forest Land	5-39
5.3	INLAND FLOODING	5-43
5.4	EROSION AND SEDIMENT	5-50
	A. Erosion	5-53
	B. Sediment	5-67
5.5	WETLANDS	5-71
5.6	WATER QUALITY	5-85
5.7	WATER SUPPLY AND IRRIGATION	5-94
	A. Water Supply	5-94
	B. Irrigation	5-94
5.8	FISH AND WILDLIFE	5-97
	5.81 FISH	5-98
	5.82 WILDLIFE	5-108
5.9	RECREATION	5-124
5.10	EXISTING PROGRAMS	5-131

CHAPTER 6 - FUTURE-WITHOUT-PLAN CONDITION

6.1	DEFINITION AND USE	6- 1
6.2	IMPLICATIONS OF ECONOMIC AND SOCIAL PROJECTIONS TO ENVIRONMENTAL SITUATIONS	6- 2

TABLE OF CONTENTS (Continued)

Page Number

6.3	DESCRIPTION OF FUTURE-WITHOUT-PLAN CONDITION	6- 3
A.	Agricultural Land	6- 3
B.	Forestland	6- 4
C.	Inland Flooding	6- 6
D.	Wetlands	6- 9
E.	Erosion and Sediment	6-12
F.	Water Quality	6-13
G.	Water Supply	6-14
H.	Recreation	6-17

CHAPTER 7 - NEEDS

7.1	INTRODUCTION	7- 1
7.2	NEEDS	7- 1
A.	Agricultural Land	7- 1
B.	Forestland	7- 3
C.	Flooding	7- 4
D.	Erosion and Sediment	7- 5
E.	Wetlands	7- 7
F.	Recreation	7- 8

CHAPTER 8 - ALTERNATIVES

8.1	INTRODUCTION	8- 1
8.2	LAND USE ALTERNATIVES	8- 1
A.	Agricultural Land Use Alternatives	8- 1
B.	Forestland	8- 5
8.3	FLOODING ALTERNATIVES	8- 7
A.	Coastal Region Flooding Alternatives	8-10
8.4	SEDIMENT AND EROSION ALTERNATIVES	8-13
A.	Construction Areas	8-13
B.	Critical Erosion Areas	8-14
C.	Tilled Cropland	8-14

TABLE OF CONTENTS (Continued)

Page Number

8.5	WETLANDS ALTERNATIVES	8-17
	A. Public Acquisition	8-18
	B. Inland Wetlands Restriction Program	8-20
	C. Protective Zoning	8-20
8.6	WATER QUALITY ALTERNATIVES	8-21
8.7	WATER SUPPLY ALTERNATIVES	8-22
8.8	RECREATION ALTERNATIVES	8-23
8.9	ALTERNATIVE ACCOUNTS DISPLAY	8-29
8.10	ENVIRONMENTAL IMPACTS	8-40

CHAPTER 9 - PROGRAM IMPLEMENTATION OF ALTERNATIVES

9.1	INTRODUCTION	9- 1
9.2	OPPORTUNITIES FOR USDA PROGRAMS	9- 1
	A. Soil Conservation Service Programs	9- 1
	B. Forest Service Programs	9- 7
	C. Farmers Home Administration Programs	9- 7
9.3	OPPORTUNITIES FOR OTHER PROGRAMS	9- 8
	A. Federal Programs	9- 8
	B. State Programs	9- 9
	C. Regional Programs	9-11

APPENDICES

A	Prime Potential Reservoir Sites
B	Wetland Evaluation Criteria
C	Public Lakes, Ponds, and Reservoirs

CHAPTER 1 - SUMMARY

1.1 INTRODUCTION

This is a report of a study of the water and related land resources of the region, prepared by the U.S. Department of Agriculture (USDA) and the Massachusetts Water Resources Commission. There will be similar reports for the remaining regions of Massachusetts. The objectives of this study are to identify problems, determine needs through 1990, and suggest alternatives which can be used by the Massachusetts Water Resources Commission to prepare a comprehensive state water and related land resources plan. Information contained in this report will be useful to state, regional, and local agencies concerned with land use and natural resource planning.

For the purposes of the Massachusetts Water Resources Study, the state was divided into four regions: Berkshire, Connecticut River, Central, and Coastal. The Charles River Region was not included, since studies in that area were completed in 1972 in a cooperative Charles River Implementation Study, with the Corps of Engineers. Figure 1.1 indicates the regions.

The Coastal Region, approximately 2,600 square miles, consists of small watersheds which flow directly into the Atlantic Ocean. Major streams are the Parker, Ipswich, Saugus, Mystic, Neponset, North, Taunton, Agawam, Weweantic, Westport, Sippican, Mattapoisett, Ten Mile, and Palmer Rivers. The region is composed of 127 cities or towns in eastern Massachusetts.

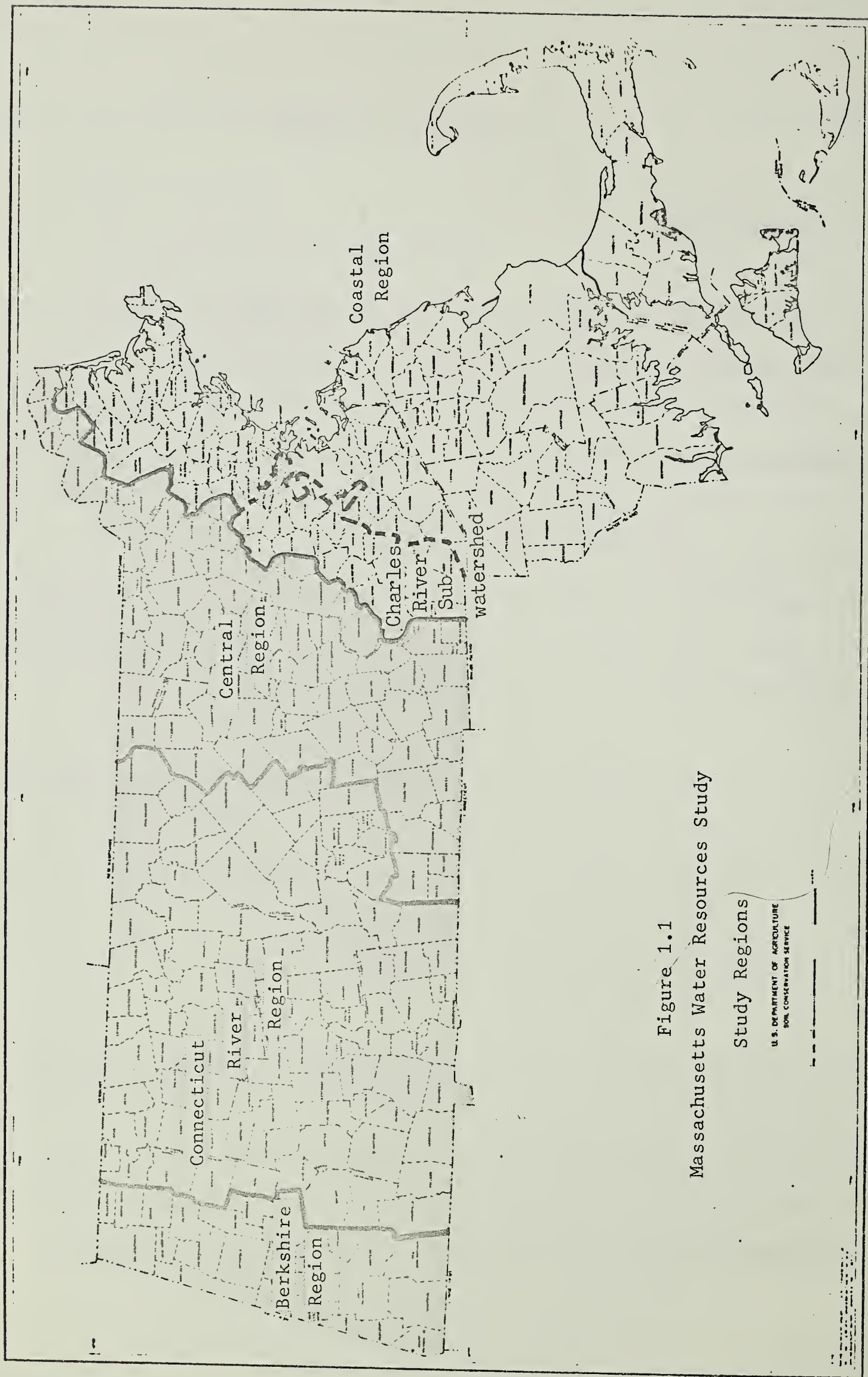


Figure 1.1
Massachusetts Water Resources Study
Study Regions

The Soil Conservation Service, Economic Research Service, and the Forest Service are the United States Department of Agriculture agencies participating in this study. The Massachusetts Divisions of Water Resources, Fisheries and Wildlife, Forests and Parks, Water Pollution Control, and the Massachusetts Department of Agriculture are the state agencies most actively involved in this study.

1.2 CONCLUSIONS OF THE STUDY

A. Land Use

The 1975 population of the region was about 2,900,000 people. The population is expected to increase 11 percent to about 3,209,000 people by 1990.

Land use in the Coastal Region is dominated by forest and urban uses. Approximately 75 percent of the land area or 1,250,000 acres is in the above two land use categories. Over 20 percent of the land is in urban use. Agricultural land, wetlands, water, and "other" land uses contribute to the balance.

During the 20-year period between 1952 and 1972, significant changes in land use have occurred, especially in the agricultural and urban land use categories. Agricultural land decreased by almost 99,169 acres, while urban land increased by 145,062 acres. Projections of trends in agricultural land suggest that total land in farms will decrease by 4.2 percent (6,574 acres) between 1974 and 1990. Projections also indicate that urban land is expected to increase by 16 percent (54,191 acres) by 1990.

The state as well as the region is experiencing a continuing decrease in the quantity of agricultural land. The loss of suitable farmland soils to other land uses is nearly irreversible. In addition to reducing the land base available for growing food, the loss of farmland results in a deterioration of the visual and aesthetic quality of the environment. Alternatives and remedial measures are suggested which, if implemented, might stem the trend of decreasing agricultural land use.

Forest land presently occupies 908,000 acres or 54 percent of the region. Projections suggest that forest land will decrease to 863,000 acres by 1990. Private owners own the majority of the forested land, and much of the land consists of small tracts. Land is owned for a variety of reasons, only a small proportion for timber production purposes and perhaps only one-half the forest land is available for wood product production. Alternatives to increase wood product production include an increase in personnel; increase in forest program funding and forest land ownership incentives; development of diversified markets for low quality wood; and an increase in information and education programs.

B. Inland Flooding

Within the last 50 years, many floods have occurred in the region. but the more significant regional floods occurred in 1938, 1944, 1955, and 1968. These floods damaged residences, commercial buildings, industrial plants, farm fields, roads, and bridges.

Average annual flood damage in the region exceeds \$2,750,000. A 100-year frequency flood would cause damage in excess of \$21,000,000.

To reduce flood hazard risks in future development, many towns in the region are adopting flood plain management techniques, such as flood plain zoning and flood insurance. All but seven towns have joined the National Flood Insurance Program, and property owners can now purchase low cost flood insurance. In return for this federally-subsidized insurance, the towns are required to regulate future construction in flood hazard areas.

As a result of the flood insurance program and the growing tendency to adopt flood plain management measures, future flood plain development is expected to be highly restricted. As a consequence, flood damage is not expected to increase significantly.

Flood plain regulations and flood insurance will not reduce flood damage to existing development. There is a need to develop alternatives to reduce flood damage in the region to an acceptable level. Alternatives are available to significantly reduce flood damage. Three combinations of corrective flood plain management techniques were investigated in this study. Floodproofing, structural measures, or a combination of floodproofing and structural measures offer viable alternatives to continued flood damage.

C. Erosion and Sediment

The region is blessed with generally less severe erosion and sedimentation problems than much of the rest of the United States. However, these problems cannot be discounted entirely. The annual erosion in the region is approximately 690,000 tons. About 69,000 tons of sediment are delivered to watercourses each year. Erosion from construction sites accounts for over 340,000 tons per year. Tilled cropland accounts for 60,000 tons. Wind erosion from sand dunes, gravel pits, and utility rights-of-way results in nuisance-type problems for nearby residents.

Enactment of erosion and sediment control ordinances, stabilization of critical erosion problem areas, and increased emphasis on the installation of land treatment measures on tilled cropland are suggested as alternatives to alleviate the erosion and sediment problems.

D. Wetlands

The 159,000-acres of inland wetlands and 40,000-acres of saltwater wetlands in the region provide many benefits, including flood control, wildlife habitat, open space, and water quality protection. The ongoing wetlands programs, especially Massachusetts' pioneer wetlands legislation, will go far in protecting wetlands from harmful alteration.

Increased public acquisition of wetlands, acceleration of the Inland Wetlands Restriction Program, and expanded conservancy zoning of wetlands are included in the alternatives. The Saltwater Wetlands Restriction Program is expected to adequately protect all salt marshes by 1990.

E. Water Supply and Irrigation

The municipal water for the Coastal Region is supplied from groundwater and surface sources, and by purchase from the Metropolitan District

Commission (MDC). Additional municipal water supply is needed. Diversion of Connecticut River Water is being considered to meet 1990 needs of the Boston metropolitan area served by the MDC. Appendix A of this report identifies 33 potential reservoir sites which might fill needs for municipal water supply for individual communities or small regional systems.

Irrigation water used by agriculture represents a very small part of the total water supply and water use in the region. The majority of irrigation water is used in the production of cranberries. Water supplies for this purpose are expected to be adequate to meet 1990 needs.

F. Water Quality

Existing programs and regulations are adequate to enable the region to meet water quality goals. Point sources of pollution have been drastically reduced in the past five years, and additional progress is expected. Nonpoint sources of water pollution are receiving increased attention under Section 208 of the Water Pollution Control Act Amendments of 1972.

Alternatives in the area of Water Quality include acceleration of the soil survey program in the region.

G. Recreation

Projections in the Statewide Comprehensive Outdoor Recreation Plan indicate that an unmet demand exists now and will exist in 1990 for camping, picnicking, canoeing, sailing, and hiking. The gap between demand and supply is so large that it will be practically impossible to meet projected needs. Alternatives are presented, however, which can meet some of the needs.

Alternatives include development of environmental corridors, development of canoe trails, and implementation of the Massachusetts Scenic and Recreational Rivers Act.

1.3 SUMMARY TABLES

Table 1.1 summarizes the major findings, problems, potential solutions, and program opportunities determined, as a result of this study.

TABLE 1.1 - PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
1. Land Use	1. Agricultural land acreage has declined 48% from 1952 to 1972 & is projected to decline further.	Develop programs that help maintain agricultural land use.	Identify prime agricultural lands (Soils).	Farm management and farm account work at U. of Mass. and with Cooperative Extension Service. Chapter 61A of the Mass. General Laws, Chapter 780, Acts of 1977, Chapter 232, Acts of 1977.
	2. Forestland (approximately 54% of the region) is underutilized for the production of wood products.	Increase management of public & private land. Increase incentives to landowners. Develop diversified markets. Establish an information and education program.	1. Resource conservation & development program. 2. Cooperative forest management program. 3. General forestry assistance program. 4. Harvest improvement program. 5. Forestry incentive program. 6. Sawmill improvement program.	1. Chapters 61 and 61A of Mass. General Laws. 2. Farmers Home Administration. 3. Small Business Administration.

TABLE 1.1 - PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
2. Flooding	1. Future urban flood plain development is expected to be highly restricted.	Enroll towns not now in National Flood Insurance Programs.		HUD National Flood Insurance Program.
	2. Average annual flood damage to existing development exceeds \$2,750,000.	Implement plans for structural measures and flood proofing to reduce flood damages.	1. PL 83-566, Watershed Protection & Flood Prevention Act, administered by USDA, SCS.	Corps of Engineers' Small Watersheds and Emergency Projects.
3. Erosion and Sediment			2. RC&D Program.	
	1. Erosion on construction sites is an important erosion problem.	Develop erosion and sediment control ordinances at the municipal level.	Conservation Operations Program, SCS.	Technical assistance from Conservation Districts with inputs from Cooperative Extension Service and County Regional Planning Commissions.
	2. Region has critical erosion problem areas and problem streambanks.	Develop Resource, Conservation & Development project measure to stabilize critical areas and problem streambanks.	RC&D Program.	
	3. Erosion rates on tilled cropland are unacceptably high and result in lowered agricultural productivity.	Inventory cropland with serious erosion problems. Establish priorities for technical and financial assistance to assist landowners install practices to reduce erosion losses.	Conservation Operations Program, SCS.	Technical assistance from Conservation Districts.

TABLE 1.1 - PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
4. Wetlands	1. Region has 159,000 acres of wetlands which should be protected from harmful alteration.	Accelerate Inland Wetlands Restriction Program.		
		Acquire additional 20,000 acres of inland wetlands by 1990.		Financial assistance for cities and towns for acquisition, state - Self-Help Fund, Gen. Laws, Ch. 132A, Sec. 11.
				Federal - USDI - BOR Land and Water Conservation Fund.
		Expand conservancy zoning to include majority of the region's wetlands.	Mass. Natural Resources Technical Team.	Technical assistance from Conservation Districts.

TABLE 1.1 - PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
5. Water Quality	1. Ongoing problems on verge of reestablishing high water quality in the streams of the region.			
	2. "Section 208" water quality studies underway in the region.			
	3. Detailed soil survey information is not available for entire region.	Provide detailed soil survey.	Special soils surveys and interpretations to be prepared for towns by SCS.	
	4. Water pollution from pesticides and herbicides used in cranberry operations are a potential problem.	Continue to educate operators concerning potential water quality hazards.	Cooperative Extension Service. Cranberry Experiment Station.	

TABLE 1.1 - PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
6. Water Supply and Irrigation	1. Additional municipal water supply will be needed by 1990.	Additional water supply can be developed from groundwater and/or surface water sources. Diversion of Connecticut River water may be needed to meet MDC needs. Potential surface water reservoirs indicated in Appendix A.	USDA Farmers Home Administration loans for community water supply systems.	HUD loans and financial assistance for municipal water supply.
	2. Little irrigation water use, except for cranberry production. Existing programs are adequate.			

TABLE 1.1 - PROBLEMS AND OTHER FINDINGS OF THE STUDY

Resource Area	Findings/Problems	Potential Solutions and Needed Actions	Program Opportunities	
			USDA	Other
7. Recreation	1. There are insufficient camping, picnicking, and boating facilities.	Provide additional camping, picnicking, swimming, and boating facilities.	Resource Conservation and Development Program.	1. USDI - BOR Land and Water Conservation Fund.
				2. Mass. - Self-Help Fund, Gen. Laws, Ch. 132A, Sec. 11.
				3. Mass. - Public Access Fund, Gen. Laws, Ch. 21, Sec. 17.
	2. Region has numerous unique natural features.	Plan for preservation of scenic rivers and unique natural areas.	Renewable Resources Program. USDA - Forest Service and Mass. Div. of Forests and Parks.	Nature Conservancy Program.
				Mass. Scenic and Recreational Rivers Program.
			SCS Mass. Natural Resources Planning Program.	

CHAPTER 2 - INTRODUCTION

2.1 GENERAL

The Massachusetts Water Resources Study was initiated by a cooperative agreement between the U.S. Department of Agriculture (USDA) and the Massachusetts Water Resources Commission (MWRC). This water and related land resources study provides data to the Commission for use in the preparation of an overall State Water and Related Land Resources Plan.

2.2 AUTHORITY FOR USDA AND OTHERS' PARTICIPATION

The USDA participated in this study at the request of the MWRC. Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 83-566, as amended) authorizes such participation by USDA. The Forest Service, Economic Research Service, and the Soil Conservation Service are the USDA agencies participating in this study.

Under state law, the MWRC has the responsibility to develop the overall plan and to coordinate federal, state, and other agency activities in the water resources field.

The Massachusetts Divisions of Water Resources, Forests and Parks, Fisheries and Wildlife, and Water Pollution Control are the state agencies most actively involved in this study.

2.3 OBJECTIVES AND NATURE OF STUDY

Water and related land resource planning by federal agencies is guided by the Principles and Standards (P&S) established by the federal Water Resources Council. The Principles and Standards established a thorough and organized approach to water and related land resource planning for two broad objectives:

National Economic Development (NED)--to enhance national economic development by increasing the value of the nation's output of goods and services and improving national economic efficiency.

Environmental Quality (EQ)--to enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

2.4 PLANNING PROCEDURES AND REPORT PRESENTATION

The planning process, established by the P&S, is designed to produce a recommended plan. The Massachusetts Water Resources Study planning process differs in that the process stops with the development of alternatives. The selection of a final or recommended plan is the responsibility of the Massachusetts Water Resources Commission.

This study investigated the following resource areas in detail: Land Use, Inland Flooding, Erosion and Sediment, and Wetlands. The resource areas of Water Quality, Water Supply and Irrigation, Drainage, Fish and Wildlife, and Recreation are ordinarily subjects of investigation for a cooperative water resources study. In the Coastal Region, however, these resource areas have been studied in detail by other levels of water resources studies, state sponsored studies, and by consulting engineers and planners. To avoid duplication of effort and to allow more time and effort to be expended upon the four areas studied in detail, it was decided to only briefly investigate the other areas. In some cases, the data and conclusions from previous studies are reported to maintain continuity. In other instances, it was found that new resource data could be generated in a specific phase of a resource area. The principles which guided study intensity were:

1. Areas that were adequately covered by previous studies would not be restudied, and
2. only resource areas where the expertise of USDA agencies was recognized would be studied in detail.

The Massachusetts Water Resources Study planning process approximates the first four steps of the P&S process which are as follows:

1. Specify components of the objectives relevant to the planning setting;
2. evaluate resource capabilities and expected conditions without any plan;

3. formulate alternative plans to achieve varying level of contributions to the specified components of the objectives;
4. analyze the differences among alternative plans which reflect difference emphasis among the specified components of the objectives.

In addition, the P&S requires that beneficial and adverse effects of alternatives or plans on National Economic Development and Environmental Quality be displayed. P&S also suggests that beneficial and adverse effects of alternatives be displayed, where appropriate, for Regional Development and Social Well-Being.

Study results are presented in chapters which reflect the P&S suggested planning process. Data findings in each resource area are placed in the appropriate planning chapter, so that the final report enables the reader to follow the step-by-step procedures used to develop the alternatives. The major chapter format is, as follows:

Chapter 3 (Problems and Objectives) - The resource problems are stated in terms of their effect on the two main objectives: National Economic Development and Environmental Quality.

Chapter 4 (Economic Projections and Environmental Consideration) - Projections of social, economic, and natural resources base data are presented, including projections of population, employment, income, urban development, agricultural and forest activity, and other significant social and economic areas. The relationship between the projections and specific components of the National Economic Development objectives are presented.

Projections concerning the environmental setting are also contained in this chapter. Effects of population distribution and land use changes on the environment are discussed.

Chapter 5 (Resource Base and Existing Programs) - The existing situation is presented in this chapter. Physical data, such as location, size, soils, geology, vegetative cover, climate, and land use are included. Existing conditions in the four major resource areas (flooding, erosion and sediment, wetlands, and land use) are covered in detail. Existing USDA and other programs which are being utilized to meet resource needs are explained in this chapter.

Chapter 6 (Future-Without-Plan Condition) - This chapter describes the conditions to be expected in each of the resource areas if no new alternatives are planned and implemented. The effects of presently authorized projects are considered along with the effects of nonaction.

Chapter 7 (Needs) - Needs are defined as the difference between conditions expressed in the Economic Projections and Environmental Considerations section and those adequately addressed by ongoing and planned projects described in the Future-Without-Plan Condition Chapter. This chapter quantifies the extent of the problems outlined in the Problems and Objectives Chapter.

Chapter 8 (Alternatives) - This chapter presents a number of alternatives designed to fill the needs expressed in the preceding chapter. Displays showing effects of the alternatives on the four P&S accounts (National

Economic Development, Environmental Quality, Regional Development, and Social Well-Being) are included. In addition, alternatives are contrasted with their potential effects on about 20 major environmental indicators.

Chapter 9 (Program Implementation of Alternatives) - The chapter describes how USDA programs can be used to implement the alternatives expressed in Chapter 8. Opportunities for other state or federal programs are also discussed. If no existing programs are available to implement an alternative, the need for new or revised programs is investigated.

2.5 GENERAL DESCRIPTION OF THE STUDY AREA

The Coastal Region includes all the coastal watersheds and offshore islands from the Parker River in the north to the Buzzards Bay and Narragansett Bay drainage in the southeast portion of Massachusetts. It is bounded by the Merrimack River and the Blackstone River Basins on the north and west, and by the Atlantic Ocean on the east and south. Larger rivers in the region include the Ipswich, Neponset, Taunton, and the Ten Mile.

The region includes the entire counties of Dukes, Bristol, Plymouth, Barnstable, Suffolk, and Nantucket, and parts of Essex, Middlesex, and Norfolk Counties. The region is the cultural and economic center for not only Massachusetts but for the entire New England area.

The region is composed of 127 towns or cities and 10 study areas which are defined on either a watershed or on a natural boundary basis. For the purposes of this study, the 10-study areas were aggregated into three sub-regional areas with names denoting the geographical location in the state. Figure 2.1 indicates the location of study areas.

<u>Subregion</u>	<u>Study Areas</u>
1. Northeastern	a. Parker
	b. Ipswich
	c. North Shore
	d. Neponset
2. Southeastern	a. South Shore
	b. Taunton
	c. Buzzards Bay
	d. Narragansett Bay
3. Cape Cod and Islands	a. Cape Cod
	b. Islands

Where applicable, data and findings will be presented for each subregional area. In those cases where no improvement will be made, presentations will be for the entire Coastal Region.

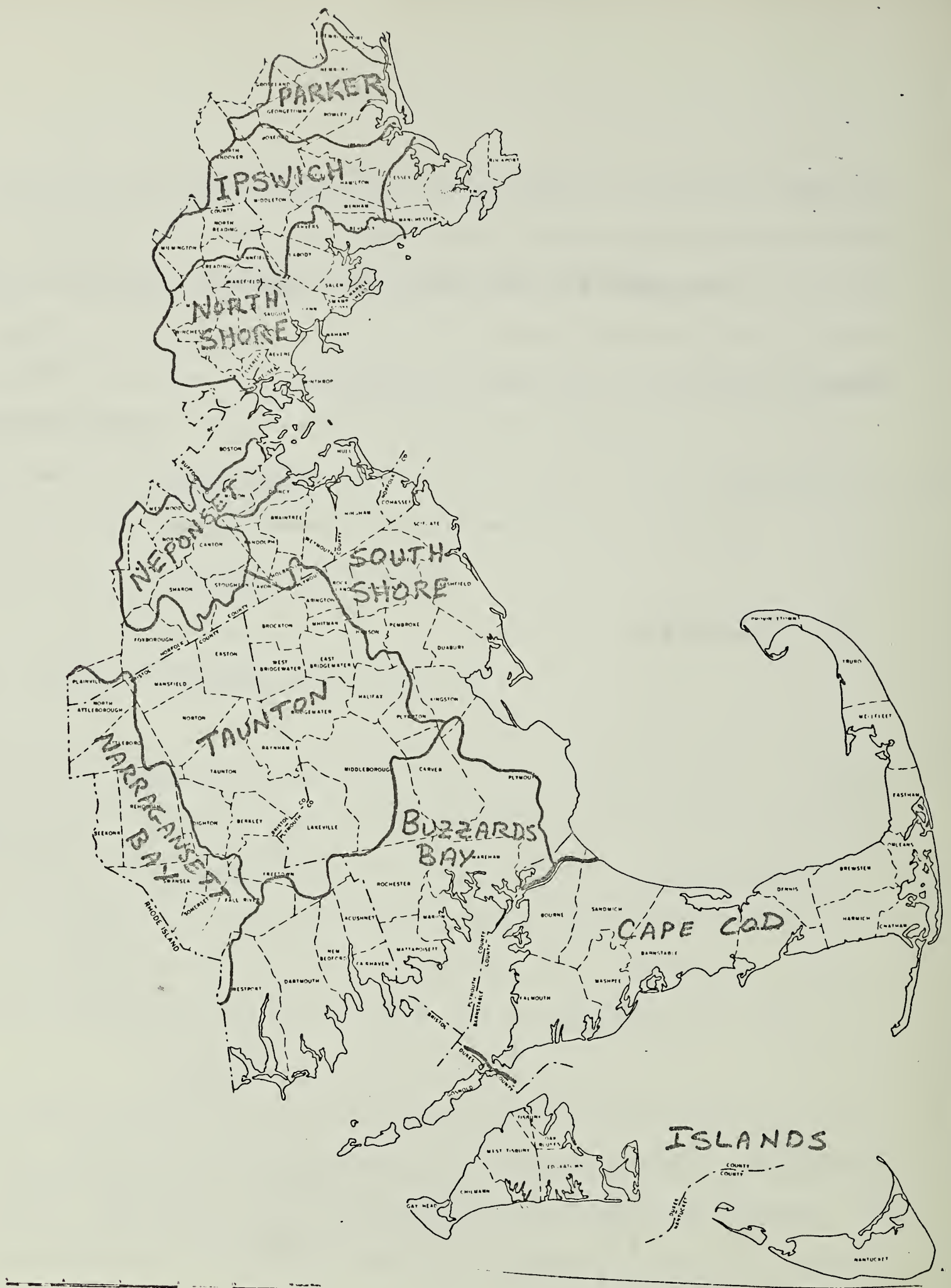


Figure 2.1
The Coastal Region

A. POPULATION

The total permanent population of the Coastal Region was 2,901,540 in 1975, an increase of 82,140 since 1970 (2.8 percent) and an increase of 302,907 since 1960 (11.7 percent). In comparison to the regional trend, the Boston population trends were just the opposite, losing populations of 53,197 between 1960 and 1975, and 2,071 between 1970 and 1975. Table 2.1 summarizes the permanent population trends for each of the subregions.

TABLE 2.1 - POPULATION AND POPULATION (PERMANENT) CHANGES
1950-1975

Item	Subregions			
	Northeastern	Southeastern	Cape Cod & Islands	Total Coastal Region
1950	1,588,530	751,370	51,353	2,391,253
1960	1,606,923	915,581	76,129	2,598,633
1970	1,648,453	1,067,470	103,447	2,819,370
1975	1,634,966	1,125,464	141,110	2,901,540
Change				
1950-75	46,436	374,094	89,757	510,287
% Change				
1950-75	2.9	49.8	174.8	21.3
Change				
1960-75	28,013	209,888	64,981	302,907
% Change				
1960-75	1.7	22.9	25.4	11.7
Change				
1970-75	-13,487	57,994	37,633	82,140
% Change				
1970-75	-.8	5.4	36.4	2.9

B. ECONOMIC ACTIVITY

Presently, manufacturing is one of the largest employers in the Coastal Region. In 1970, the manufacturing sector employed slightly more than 24 percent of those employed in the region, although this was down from the 1960 figure of 31 percent. The service sector was the largest employer and accounted for slightly more than 29 percent. It is interesting to note that the number of those employed in the service sector increased from 453,772 persons in 1960 (22.6 percent of those employed) to 856,977 in 1970. At the other extreme, agriculture, forest, and fisheries accounted for just .7 percent of the total number employed in 1960 and .5 percent in 1970, while mining employed less than one-tenth of one percent.

Between 1960 and 1970, the regional transportation sector experienced a decline of 44.27 percent but, if Boston is excluded, the sector experienced an increase of almost 16 percent. Wholesale trade also illustrates the impact of Boston's employment. Between 1960 and 1970, wholesale trade increased its employment by 11.72 percent of those employed when Boston is included. When Boston is excluded, wholesale trade increased 74 percent.

The data suggests a restructuring of the economic sector from a manufacturing economy to a service-oriented economy. While manufacturing had a decrease of 71,671 persons, the service sector increased by slightly more than 204,000. The trend is the same when Boston is excluded and typifies the New England economy with manufacturing relocating outside of New England to take advantage of lower cost areas.

This purposely brief socio-economic introduction delineates the major socio-economic characteristics of the Coastal Region. The socio-economic discussion will be continued in more detail in Chapter 4.

CHAPTER 3 - PROBLEMS AND OBJECTIVES

3.1 INTRODUCTION - PRINCIPLES AND STANDARDS

According to the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources, the overall purpose of water and land resource planning is to promote the quality of life by reflecting society's preferences for attainment of two major objectives:

1. The enhancement of National Economic Development (NED) by increasing the value of the nation's output of goods and services, and improving national economic efficiency;
2. the enhancement of the Environmental Quality (EQ) by the management, conservation, preservation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The NED objective is attained by measures and actions which result in an increase in the value of goods and services and which improve national economic efficiency. An important component of the NED objective is the value of increased output of goods and services resulting from an action. Water resource alternatives can result in increased production of goods and services which can be measured in terms of increased crop yields, increased

recreational use, and reduced flood damages. Increased production from the employment of otherwise unemployed or underemployed resources may also result.

The EQ objective reflects concern for the natural environment and its maintenance and enhancement as a source of enjoyment and a heritage for future generations. Emphasis is given to diverting a portion of the available resources from economic development to achieve environmental goals. As our standards of living increase, there is less willingness to accept environmental damage in exchange for economic gain.

Specific components of the EQ objective include:

1. Creation or improvement of areas of natural beauty and human enjoyment, such as open space, wild and scenic rivers, lakes, beaches, and wild areas;
2. management or enhancement of valuable archeological, historical, biological, and geological resources;
3. enhancement of the quality of water, land, and air resources by control and prevention of pollution, erosion, and misuse;
4. caution in meeting development objectives in order to minimize undesirable and possible irreversible changes in the natural environment.

In each of the major water resource areas of concern, problems can be related to one or both of the major national objectives. Flood damages are a good example of a problem which fits into the category of a National Economic Development problem; i.e., flood damage results in a decrease in the value of goods and services which are produced in an area. The problem of loss of wetlands in a region might logically be classed as both a NED and EQ problem. Loss of wetlands results in loss of wildlife habitat (an EQ loss), as well as increased development costs, an increased potential for flood damage (NED problems).

3.2 PROBLEMS AND OBJECTIVES

Table 3.1 presents problems or concerns for each specific resource area or study concern. Objectives related to problems are presented on two major levels: desires and preferences.

TABLE 3.1 - PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives	
		1st Level (Desires)	2nd Level (Preferences)
Land Use - Agri-cultural Land	NED - Loss of agricultural land to nonagricultural uses. EQ - Loss of open land.	Preserve agricultural land. Preserve open land.	<ol style="list-style-type: none"> 1. Increase net returns to agricultural sector. 2. Determine and minimize the factors that adversely impact upon the agricultural sector.
Land Use - Forestland	NED - Under utilization of forest-land resources for the production of wood products. EQ - Lack of forest management in urban areas is resulting in a lessening of environmental quality.	Increased outputs of wood products. Preserve, maintain, and enhance the quality of the environment and the ecological system.	<ol style="list-style-type: none"> 1. Increase management opportunities for forest land-owners. 2. Provide forestland management incentives. 3. Increase market opportunities for wood products. 4. Establish and increase information and education programs on forest management. 1. Provide information and education programs on urban forestry. 2. Provide additional technical assistance for management and use of urban forest resources in the region.

TABLE 3.1 - PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives	
		1st Level (Desires)	2nd Level (Preferences)
Inland Flooding	<p>NED - Periodic flooding causes damage to existing residential, commercial, industrial, and public property.</p> <p>NED - Level of flood prone areas increases the damages to be expected from future floods.</p> <p>NED - Loss of wetland flood storage increases flood peaks and flood damage.</p>	<p>Reduction of flood damage to existing damageable property.</p> <p>Improved economic efficiency from development of flood-free areas.</p> <p>Avoid increased flood peaks and resulting damage.</p>	<p>1. Reduction of flood flows. 2. Reduction of susceptibility to flooding.</p> <p>Guide development away from flood prone areas.</p> <p>Protection of wetland flood storage from loss by filling.</p>
Erosion and Sediment	<p>EQ - Materials eroded from unstable areas are resulting in pollution and sedimentation of water bodies and decreased visual quality.</p> <p>NED - Erosion on cropland results in reduced agricultural productivity.</p>	<p>1. Enhance water quality. 2. Enhance visual quality.</p> <p>1. Maintain agricultural productivity.</p>	<p>Install erosion and sediment control measures. Install erosion and sediment control measures.</p> <p>Reduce erosion losses on cropland.</p>

TABLE 3.1 - PROBLEMS AND OBJECTIVES

Resource Area	Problems (Concerns)	Objectives	
		1st Level (Desires)	2nd Level (Preferences)
Wetlands	<p>EQ - Loss or harmful alteration of inland wetlands results in decreased wildlife habitat and visual quality.</p> <p>NED - Loss of wetland flood storage increases downstream flood peaks and flood damage.</p> <p>NED - Development of wetlands increases flood damage in the developed wetlands.</p> <p>NED - Lack of public access to wetlands is resulting in underutilization of a recreation resource.</p>	Protection of the environmental base.	Protection of wetlands from unwise development.
		Avoid increased flood peaks and resulting damage.	Protection of wetland flood storage from loss by filling.
		Reduce future flood damage.	Protect wetland flood prone areas from development.
		Increase wetland recreation opportunities.	Secure public access to wetlands.
Water Quality	EQ - Pollution from point and nonpoint sources is degrading water quality.	Improve water quality.	Identify pollution sources and develop abatement measures.
Recreation	EQ - Unique natural, historic, and cultural resources will be lost unless protected.	Management and protection of areas of natural beauty and human enjoyment.	Protect and manage unique natural, historic, and cultural resources.
	NED - Lack of public access to outdoor recreation resources.	Increase recreational opportunities.	Secure access to recreation areas.
	NED - Demand for outdoor recreation exceeds available supply.	Increase recreational opportunities.	Develop water-based recreational resources.

CHAPTER 4 - ECONOMIC PROJECTIONS AND ENVIRONMENTAL CONSIDERATIONS

4.1 HISTORIC DEVELOPMENT - GENERAL ECONOMIC DEVELOPMENT AND SIGNIFICANT EFFECTS ON THE ENVIRONMENT

Prior to colonization by England, the Coastal Region was inhabited by Native People of the Wampanoag and Massachusetts tribes. Agricultural products and fisheries were the main food supplies of the natives who lived in a dominant woodland cover.

In terms of major activities, the Coastal Region has progressed through two economic periods and entered a third. Shipbuilding, shipping, and fishing were the major commercial activities between colonization and the early 1800s. The long coastline with many natural deep anchorages and nearby timber resources gave rise to a large shipbuilding industry which subsequently developed into shipping and fishing activities. Shipping of raw products from the colonies to England and returning with manufactured goods became the most prevalent trade pattern.

England's imposition of the Stamp and Sugar Acts had a severe negative impact upon shipping, and this impact continued until after the Revolution. With the cessation of hostilities, shipping prospered until 1807, when an embargo was placed on American shipping by the federal government. As shipping floundered, resources were diverted to manufacturing, marking the beginning of the second economic period. Although shipping and related industries were

the major economic activities, manufacturing was a viable sector. The rivers that supplied an inexpensive source of power, plus the comparative advantage in water transportation, were important factors in the development of manufacturing. Although manufacturing remained the dominant economic sector through the 1960s, two economic factors dictated a decline. The first involved a transportation shift from water to land. Initially, the railroads brought about this change which was sealed with the development of the interstate highway system. The other factor involved the introduction of non-water generated power, initially steam and subsequently electricity. With the loss of the region's comparative advantage in power and transportation, manufacturing declined prior to World War I and reached its nadir between 1950 and 1970.

As a result of these structural changes, capital investments declined in the manufacturing sector and were diverted to service-related activities. As an illustration of this trend, between 1960 and 1970, employment in manufacturing decreased 11.5 percent (from 621,208 to 549,537), while employment in the service sector increased 45 percent (from 453,722 to 658,149).

The employment figures presented in Table 4.1 illustrate the dominance of Boston in the region. The decrease in manufacturing between 1960 and 1970 goes from 11.5 percent with Boston included, to 2.5 percent with Boston excluded. Similarly, the increase in the service sector goes from 45 to 59 percent.

TABLE 4.1 - EMPLOYMENT BY PLACE OF WORK, 1960, 1970.^{1/}

Employment Category	Boston Included			Boston Excluded		
	1960	1970	Change (Percent)	1960	1970	Change (Percent)
Agriculture	13,853	11,890	-1,963	12,453	11,266	-1,187
Mining	970	518	-452	417	263	-154
Construction	95,848	105,091	9,243	27,987	31,833	3,846
Manufacturing	621,208	549,537	-71,671	232,710	226,987	-5,723
Transportation	117,713	65,603	-52,110	22,907	26,569	3,662
Wholesale	128,783	143,870	15,087	14,777	25,740	10,963
Retail	307,940	389,527	81,587	90,334	130,437	40,103
Finance, Insurance, and Real Estate	111,321	142,695	31,374	14,424	20,092	5,668
Other Services	342,451	515,454	173,003	78,707	127,709	49,002
Government	269,602	341,523	71,921	70,216	97,584	27,368
Total employment ^{a/}	2,009,689	2,265,708	256,019	564,932	698,480	133,548
			12.74			23.64

a/ Total employment figures will differ from census figures which are based upon place of residence.

1/ SOURCE: Employment data by place of work is from the Empiric Data File developed by John Green, ERS, USDA, for use in the SENE study.

Like the manufacturing sector, the agricultural sector evolved through three economic or productive stages:

1. Prerailroad (ending about 1840)--agricultural production concentrated primarily upon supplying nearby cities and provisioning ships with food.
2. Transition stage (1840-1910)--staple products were increasingly shipped from the "western" areas (i.e., Indiana, Ohio, New York, etc.).
3. Present pattern (1910 on)--agriculture primarily involved in providing perishable type foods produced near point of consumption.

These three stages occurred as a result of other changes in the economic structure in the eastern United States. As ship transportation gave way to railroads, New England began to lose its comparative advantage of inexpensive water transportation. Thus, New England farmers turned to feeding local factory workers and nonperishable commodities were imported from other areas of the country.

The agricultural and forestry sectors contribute less than one percent to total employment and, as Table 4.2 shows, a like amount to total earnings. Thus, from an economic viewpoint, these two sectors are relatively insignificant. But from a resource planning perspective, the fact that over 60 percent of the land area is in agricultural and forestry uses implies that a simple economic viewpoint does not suffice. To the extent that the land use mix is associated with water and related land resource management, as well as visual and environmental quality, agriculture and forestland must be a prime consideration in resource planning.

Table 4.2 also indicates the relative positions of the major economic sectors in the region. Although earnings in the manufacturing sector increased by almost 19 percent between 1962 and 1970, increases in the service-related sectors (service, government, finance, insurance and real estate) increased by nearly 61 percent. As was mentioned earlier, employment increases paralleled this growth in earnings.

TABLE 4.2 - POPULATION, EMPLOYMENT, PERSONAL INCOME AND EARNINGS BY INDUSTRY
Historical 1950, 1962 and 1970 ^{1/}

ITEM	1950	1962 ^{a/}	1970
Population, Midyear*	3,443,595	3,838,982	4,160,187
Per Capita Income (1967 dollar)	2,263	2,952	3,958
Per Capita Income Relative (U.S.=1.00)	1.10	1.14	1.14
Total Employment	1,351,554	1,500,971	1,723,537
Employment Population Ratio	.39	.39	.41
-----In Thousands of 1967 Dollars-----			
Total Personal Income	7,790,414	11,331,659	16,464,485
Total Earnings	6,233,458	9,203,213	12,967,402
Agriculture, Forestry & Fisheries	101,190	70,837	62,260
Mining	3,469	4,713	4,044
Contract Construction	378,933	509,735	824,967
Manufacturing	2,096,452	2,961,606	3,521,467
Transportation, Communication and Public Utilities	439,452	605,234	845,583
Wholesale and Retail Trade	1,307,039	1,681,912	2,284,519
Finance, Insurance, Real Estate	348,000	607,683	878,114
Services (includes government)	1,548,704	2,753,875	4,528,013

a/ Employment is for 1960.

* The geographical area represented by the OBERS report is larger than the Coastal Region.

^{1/} SOURCE: 1972 OBERS Projections, Regional Economic Activity in the U.S., Series E Population, Volume 5, Standard Metropolitan Statistical Areas, pp. 40 and 79.

The quality of the environment is tied very closely to the extent and type of economic activity being carried on in the region. In the colonial period through the 1800s, little concern was given to the waste by-products of production and consumption. Air and water were both considered to be free goods with no costs for their use. But as manufacturing grew and as population increased, the ever increasing amounts of waste became too concentrated to be assimilated into the environment. Once this stage was reached, air and water quality decreased. Individual towns in the region, however, took some action early. For example, in 1692, Massachusetts Bay Colony passed an ordinance which was entitled: "An Act for Prevention of Common Nuisances." This act directed the selectmen of the towns of Boston, Salem, Charlestown, and other market towns to designate specific areas within those towns, wherein slaughter houses, tallow chandlers and curriers could operate. A butcher butchering livestock outside of the designated area would be liable to a fine. Water supply regulations also illustrate that the public recognized that degradation of water quality could have adverse impacts upon the public health. To minimize such degradation, laws were passed which permitted the control of upper watersheds which flow into water supply systems.

The water quality situation seems to be improving with most of the region's waters, except those bearing the heaviest pollution burdens, expected to be fishable and swimmable by 1977, and the rest by 1983. The areas suffering most are primarily coastal harbors that still receive effluent overflows from sewage treatment plants and industrial plants. It is worthy to note one conclusion reached in the SENE report. The changing economic structure of the

region, from manufacturing sector dominance to service sector dominance, implies that a relatively lower demand will be placed upon the water and related land resources. As a consequence, the ability of the region to meet environmental goals may be more easily attainable than one would expect. Economic growth objectives can be attained without scuttling environmental standards.

4.2 SOCIO-ECONOMIC DATA

A. Projections and Relationship to OBERS

The OBERS projections are a nationally consistent set of projections for a region based on assumptions of national scope. State and local planners are encouraged to make their own projections based on known local conditions and compare them with OBERS.

The intentions of the OBERS projections are clearly described by the director of the Water Resources Council:

The OBERS projections are intended as a planning tool, as a contribution to planning decisions. Wherever water and related land development problems may be solved by alternative levels of growth, through more or less resource development, full consideration should be given to such action, uninhibited by the projections contained in this report.

The OBERS projections are not a goal. It is not intended that they be used as assigned shares, or quotas. They are not intended as a constraint on any region's economic activity. They do not express what is desirable or undesirable.

Some of the economic activity projections in this report were taken from OBERS projections, Series E, while others were developed by state and regional planning agencies.

Although direct comparisons with OBERS projections are not possible in terms of percentages, similar rates of growth are projected. The geographical area covered by OBERS extends outward from the Coastal Region's boundaries and includes some of the more densely settled areas in the Boston metropolitan area. When this factor is considered, the OBERS projections and those developed by the state and regional planning agencies do not significantly differ.

B. Employment

As noted in the previous section, OBERS data was gathered from an area slightly larger than the Coastal Region. For that reason, the discussions using OBERS data should be considered only as an indication of relative changes in employment and associated economic activities. Whenever possible, most of the economic material presented here will reflect the characteristics of the Coastal Region, per se. A comparison with OBERS will be undertaken, when appropriate.

Employment data used in OBERS are based upon employment by place of residence which do not necessarily reflect actual employment by place

of work. For that reason, in the Coastal Region, data was developed on employment by place of residence and by place of work.

TABLE 4.3 - COMPARISON OF EMPLOYMENT DATA

Item	Total Regional Employment ^{a/}	
	1960	1970
Employment by residence	1,621,228	1,853,757
Employment by place of work	2,009,689	2,265,708

a/ The employment data includes estimates for particular categories of employment not usually included in state gathering efforts.

SOURCE: Barber, Brian, and John W. Green, A Procedure for Determining Town Employment by Place of Work. ERS, USDA (Broomall, Pennsylvania, 1974).

As Table 4.3 shows, there are obviously a large number of employees who work in the region, yet live outside it. Because of this, an accounting of employment by place of residence may not give an accurate indication of the economic activity within a particular region. The controlling factor in such analysis is the location and size of the employment center within the Coastal Region, and its sphere of influence exceeds the boundaries of the region. If the region included all the bedroom communities in the Boston sphere of influence, we would see the two categories of employment converging.

C. Income

The Coastal Region enjoys a per capita income that has consistently been above the national average. In 1962, the per capita income in the region was \$2,952 and increased 34 percent by 1970 to \$3,958 (1967 dollars). The average per capita income in the United States in those two years was \$2,577 and \$3,460, respectively. Thus, in 1962, the region enjoyed a per capita income 14.5 percent above the national average. In 1970, the margin was 14.4 percent. Projections to 1990 show an increase in per capita income. Expected increases in leisure time, together with increases in disposable income, will result in increased recreational demands and, indirectly, an increased demand upon water and related land resources.

D. Urban Centers and Their Influences

As illustrated, Boston is clearly the dominant urban center in the Coastal Region and for most of New England. Boston enjoys a highly diversified economy, being the center for government, professional, financial, insurance, real estate, business and repair services, wholesale and retail trade, printing and publishing, and technical manufacturing.

The other major urban center in the region is the Fall River-New Bedford Standard Metropolitan Statistical Area (SMSA). This center is engaged primarily in manufacturing and is not nearly as diversified as the Boston area. This limited diversification is reflected in the lower per capita

income of this urban center, as the economic structure changes from manufacturing to service-related industries. For example, in 1950, the per capita income of the Fall River-New Bedford area was 2 percent above the national average but, in 1969, it was 6 percent less. Projections suggest that this same disparity will exist in 1990 and worsen in 2020. This trend results from the continuing relocation of manufacturing firms out of the region. The service sector has not picked up the slack.

E. Transportation

The Coastal Region is fortunate to have a diversified and relatively efficient transportation network. There are numerous federal, state, and local highways in the region with U.S. Routes 1 and 3 running north and south, as does I-95. State Routes 9 and 2 run in a primary east-west direction, while 138 runs south from Boston through Taunton and Fall River to the Providence, Rhode Island area. Interstate Route 495 forms an outer beltway which connects New Hampshire and Rhode Island. The Massachusetts Turnpike (I-90) runs east and west, connecting Pittsfield in the west, to Boston in the east. State Route 128 is the inner beltway around Boston which was designed to provide less congested driving around the periphery.

Railroad service is excellent and serves most of the region. Tied closely to this is the rail mass transportation system, considered to be one of the best in the country. Waterborne shipping systems are also significant. Boston serves as the major port in terms of cargo tonnage of foreign and intercoastal shipping activity. New Bedford is

next in size. Logan International Airport, located immediately north and adjacent to Boston harbor, is the center for air transport and air freight. In addition to international and national airlines, Logan Airport is also served by regional airlines that fly to other areas of the state and to municipal airports in other nearby states.

4.3 AGRICULTURAL AND FOREST RESOURCES AND RELATED ECONOMIC ACTIVITY

A. Agriculture

Major Crop and Livestock Enterprises, Volume and Value of Farm Production

The Coastal Region, like the state, has a well balanced agricultural sector but differs in that the crop and related commodities contribute more than the livestock side. In this region, crops contribute 53.4 percent, forestry products contribute .2 percent, and livestock contributes 46.4 percent. As Table 4.4 shows, the southeast subregion produced more than 78 percent of the value of agricultural products, followed by the northeast subregion share of 17 percent, and the Cape Cod and Islands 5 percent.

The major livestock enterprise in the Coastal Region is dairying which contributed approximately \$11,643,000 (26.8 percent of total agricultural receipts) in 1974. Other livestock and poultry enterprises

TABLE 4.4 - VALUE OF AGRICULTURAL PRODUCTION, PRODUCTION EXPENSES, NET VALUE, AVERAGE NET VALUE PER FARM, 1974.^{1/}

Subregion	Value of Agricultural Product	From Crops ^{2/}	From Forestry Products	From Poultry	From Livestock	Production Expenses	Net Receipts- Expenses	Number of Farms	Average Net per Farm
-----Thousands of Dollars-----									
Northeast									
All farms	7,415	4,258	37	899	2,221	6,543	872	269	3,242
Farms with sales over \$2,500	7,258	4,180	33	880	2,165	6,355	903	166	5,440
Southeast									
All farms	34,659	17,370	63	3,746	13,480	30,085	4,574	1,165	3,926
Farms with sales over \$2,500	34,115	17,102	54	3,704	13,255	29,440	4,715	775	6,084
Cape Cod & Islands ^{3/}									
All farms	2,172	1,996	5	5	166	1,803	369	146	2,527
Farms with sales over \$2,500	2,097	1,946	4	4	143	1,699	393	80	4,975
Coastal Region Total									
All farms	44,246	23,624	105	4,650	15,867	38,431	5,815	1,580	3,680
Farms with sales over \$2,500	43,470	23,228	91	4,588	15,563	37,454	6,016	1,021	5,892

1/ Basic data from 1974 Agricultural Census, with adjustments to those counties which are situated in one or more regions.

2/ Included in the crop category are crops, vegetables, hay, and nursery products.

3/ Nantucket Island is not included.

contributed \$8,508,000 (19.6 percent). If it is assumed that the percentage of cash receipts for livestock to the total agricultural receipts holds true with the expense side of the equation, then net receipts to dairy equaled \$1,605,000 or an average of nearly \$9,730.

As mentioned previously, cropping enterprises in the region contributed 53.4 percent of total agricultural marketing receipts. These enterprises are broken down into the following categories: greenhouse and nursery, vegetables, cranberries, fruit, and other crops. Cranberries contributed approximately \$10 million toward the total agricultural receipts of \$202 million (4 percent) in 1975. The fact that nearly all of the state's cranberry production takes place in the southeast subregion justifies a detailed discussion of this crop.

As most Bay Staters are aware, southeastern Massachusetts is a major cranberry producing region in the nation. Plymouth County accounts for over 80 percent of the state's production. Table 4.5 summarizes significant data on cranberry production between 1966 and 1976. As the table shows, the value of production exceeds \$10 million which equals a gross value per acre in excess of \$1,100.

In 1975, a study on current and projected water use in cranberry production was published by the Economic Research Service (ERS) as part of the Massachusetts Water Resources Study. The conclusions reached in the 1975 study were that cranberry acreage would decline 44 percent

TABLE 4.5 - CRANBERRY ACREAGE, YIELD, PRODUCTION, UTILIZATION,
PRICE AND VALUE, MASSACHUSETTS
1966-1976

Year	Acres	Yield Per Acre (Barrels)	Production ^{1/} (1000 BBLs)	Total Sales	Percent of Pro- duction Sold	Season Average Price Per Barrel ^{2/}	Value of Total Sales (\$1000)
1966	11,200	68.6	768	713	92.8	\$15.20	10,838
1967	11,200	51.2	573	503	87.8	14.90	7,495
1968	11,100	59.5	660	622	94.2	15.40	9,579
1969	11,200	67.4	755	749	99.2	15.40	11,535
1970	11,100	86.2	957	817	85.4	11.90	9,822
1971	11,100	96.6	1,072	680	63.4	15.70	10,676
1972	10,900	75.1	819	770	94.0	12.60	9,702
1973	10,900	82.7	901	809	89.8	13.60	11,002
1974	10,900	85.5	932	658	70.6	10.70	7,041
1975	10,900	72.0	785	670	85.4	12.10	8,107
1976 ^{3/}	10,900	85.8	935	850	90.1	13.10	11,135

1/ Differences between production and the total of fresh sales and sales for processing are economic abandonment.

2/ Equivalent return at first delivery point.

3/ 1976 data taken from New England Crop and Livestock Reporting Service, Statistical Reporting Service, U.S. Department of Agriculture, Massachusetts Crop Summary, July 11, 1977.

SOURCE: 1976 Massachusetts Agricultural Statistics, NECLRS, Statistical Reporting Service, USDA and Massachusetts Department of Agriculture (Boston). Page 15.

by 1990, and water use in cranberry production would decline by more than one-half by 1990.

However, a major change in the marketing structure occurred when a supply control agreement was accepted nationally and growers received individual quotas. An allotment percentage is applied to individual base quantities to determine a grower's market allotment. The obvious impact of such a market quota system is price stabilization, which has subsequent stabilizing impacts upon total cranberry acreage. As a result, cranberry acreage in Massachusetts has remained for the past 5 years at 10,900 acres. For an 11-year period, acreage has decreased 300 acres, a mere 2.7 percent.

Estimating per acre water use is extremely tenuous at best. Factors of weather, grade of bog, and pumping facilities in some bogs permitting reservoir return systems all have significant impacts upon the amounts of water required. Utilization of sprinkler irrigation systems has significant impact on water use. As a result, certain assumptions were utilized to determine water use per acre. From these assumptions, ERS developed an average acre requirement for water which amounted to 2.86 million gallons. Taking the estimated per acre water requirement and multiplying that times the projected cranberry acreage for 1990 of 10,000 acres, a revised total water need of 87,741 acre-feet for cranberry production was determined. In comparison to present water use, the 1990 figure is approximately 11 percent less. From a water supply perspective, potential problems to cranberry production areas appear to be minimal.

Employment and Income

As mentioned in Section 4.1, in comparison with the total Massachusetts economy, the agricultural sector is relatively small with gross cash receipts of approximately \$202 million in 1975. The agricultural receipts in the Coastal Region contributed approximately 22 percent to the state total or \$44,246,000. Taking the total cash receipts and subtracting production expenses of \$38,431,000 results in net income of \$5,815,000. Dividing this figure by the total number of farms in the region results in an average farm net income of \$3,680. When only those farms with sales over \$2,500 are examined, the result is an average net income of \$5,892, nearly 63 percent higher than the all farm average (See Table 4.4).

When discussing employment in the agricultural sector, it should be noted that certain problems exist when such data is compiled. Most employment data in the state is generated through the Massachusetts Division of Employment Security which collects data for employment covered under the statutes which charter it. These charters are primarily employment compensation, job referrals, and manpower planning agencies. Although expanded in recent years, the historical data series includes only employment covered by employment compensation acts which amounts to approximately 80 percent of total employment.

Barber and Green, in their work on the SENE Study, estimated the remaining 20 percent of the data for the Coastal Region. The Division of Employment Security collects data that is approximately 50-70 percent of the total employment for agriculture, fisheries, and forestry. The remainder were estimated. In 1970, total employment for the agricultural, fishery and forestry sector amounted to 11,890 individuals which represented less than 1 percent of the total labor force. As mentioned in Section 4.1, agricultural income for this same period also was less than 1 percent. These percentages are approximately the same for 1975.

Economic Factors Affecting Agriculture

One of the most obvious signs of poor economic performance of agricultural enterprises is that between 1969 and 1974, agricultural land in the state declined 83,082 acres from 700,578 acres to 617,496 acres, an 11.9 percent decline. Likewise, the number of farms decreased by 708 or a drop of 12.4 percent. The Coastal Region has experienced a similar decline. In 1969, there were 1,846 farms, compared with 1,580 in 1974, a decline of 266 or 14.4 percent. Likewise, acreage in farms declined by 16,146 acres from 172,257 to 156,111 (a 9.3-percent drop).

There are a number of factors which have contributed to the decline of agriculture in the state and in the region. Probably the most significant factor is farm profitability. In 1974, 98 percent of the agricultural receipts were accrued by only 65 percent of the farms (that category of

farm with over \$2,500 in annual sales) in the Coastal Region. There were 559 farms with sales of under \$2,500 a year. When sales income and expenses are combined, these 559 farms had an average loss of nearly \$1,750. From this point alone, it would seem reasonable that many of these 559 farms on nearly 23,000 acres will be going out of production, unless subsidized by off-farm income.

Many factors affect profitability in the agricultural sector: rising labor and capital equipment costs, shortage of labor, alternative employment with greater pay and shorter hours, taxation, lack of market output infrastructure (e.g., slaughtering houses, processing plants), nuisance laws, higher transportation rates than in competing regions, climate, and land.

The Governor and the Commissioner of Agriculture, in viewing the historical decline of the state's agricultural sector, issued "A Policy for Food and Agriculture in Massachusetts," setting forth a policy to preserve agricultural land. The statewide trend, from an agricultural perspective, is rather alarming: a decrease from 35,000 farms to a little more than 6,000 since World War II. And during the same period, farm land decreased from over 2 million acres to a little more than 700,000.

As of 1976, Massachusetts was importing 85 percent of its food: 97 percent of its meat, 70 percent of its eggs, 80 percent of its milk, and 90 percent of its potatoes. It should be noted, however, that about 25 percent of the state's total food requirements must be supplied from sources outside the

state. Of this 25 percent, 15 percent of the total food purchases cannot be produced in Massachusetts under any reasonable technical or cost assumptions. These are such foods as citrus and tropical fruits, sweet potatoes, rice, etc. The remaining 10 percent is in the form of fresh fruits and vegetables imported from other regions during those seasons when production is not possible in Massachusetts. Physically, then, Massachusetts could potentially produce 75 percent of its total food requirements, whereas today, the state is only producing 15 percent of its food requirements.

There is no question that a substantial in-state market for food exists, but it appears that economic conditions are such that Massachusetts farmers are unable to competitively supply this market. As a result of the high import demand for food commodities, Massachusetts residents pay from 6-10 percent more for their food than the national average. As a consequence, the food prices in Boston are the fourth highest of the 38-major American metropolitan areas. Much of these higher costs have been heightened by high transportation rates and a lack of storage facilities in the state.

Tied very closely to the decline in agriculture is the manner in which land resources are allocated to development. Most of the local zoning ordinances zone agricultural land as low density development; at best, an inefficient use of a scarce resource. What is necessary is an educational effort, whereby local zoning ordinances would be more flexible and lessen the pressures of development on agricultural land. Without such changes, there will be no incentive not to develop farmland.

It should be pointed out that there are only two food crops in the state where production exceeds consumption: sweet corn and cranberries. As a result, it may be necessary to introduce future programs, whereby incentives could be generated to produce a given crop or a combination of crops (land, climate, capital, and management permitting). Such a program could involve subsidies (e.g., a guaranteed outlet at a guaranteed minimum price).

B. FOREST RESOURCE

Extent and Nature of the Resource

After more than three centuries of settlement, forests occupy about 908,000 acres or 54 percent of the 1,680,000 acres in the Coastal Region.

Trees occupy the upper story of the forest resource, while shrubs, forbs, and grasses occupy the lower stories. These lower stories, along with a host of other organisms present on the forest floor, serve vital functions in the forest ecological system.

A forest is an association of tree species. The tree species associated on a specific land area are a function of soils, sites, climate, aspect, and cultural activities. Figure 4-1 shows the general association of trees in the region. Table 4.6 shows estimates on tree volume and size classes in the region.

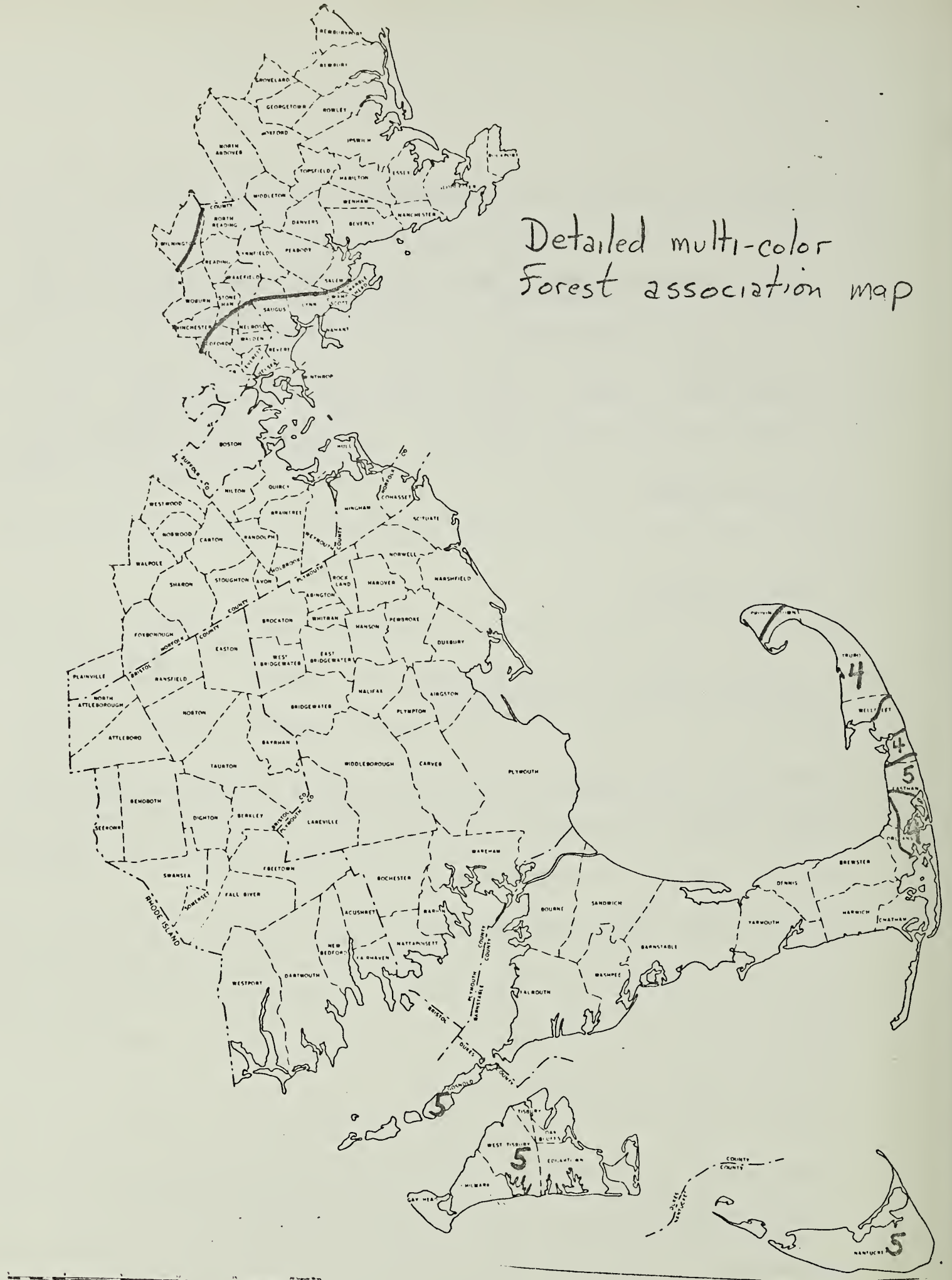


Figure 4.1
Forest Association Map

TABLE 4.6 - NET VOLUME OF GROWING STOCK ON FORESTLAND,
BY SPECIES AND TREE CLASSES, MASSACHUSETTS, 1972

Species	Net Volume (Million Cubic Feet)
White Pine	265.4
Pitch Pine	26.9
Hemlock	28.2
Other Softwoods	<u>62.1</u>
Total Softwoods	352.6
Select White Oaks	29.6
Select Red Oaks	75.4
Other Oaks	65.4
Hickory	14.5
Sugar Maple	14.7
Soft Maples	110.5
Sweet Birch	9.6
Yellow Birch	9.4
Paper Birch	11.5
Beech	6.3
White Ash	12.0
Black Cherry	11.2
Aspen	6.5
Elm	2.4
Other Hardwoods	<u>3.9</u>
Total Hardwoods	382.9
All Species	<u><u>735.5</u></u>
Sawtimber	368.7
Poletimber	<u>366.8</u>
All Classes	735.5

Utilization: Kind, Volume, and Value of Output

The forest resource provides goods and services that benefit the region's economy and environment. These goods and services can be grouped as wood products, water, forage, wildlife, and recreation.

Wood Products--The annual sawlog harvest is approximately 11.9 million board feet, valued at \$1,023,400. The majority of the sawlogs harvested are white pine. Other roundwood products are composed primarily of fuelwood and some pulpwood. Approximately 19,000 cords are harvested annually, valued at \$380,000. Total roundwood harvest annually approximates 2 million cubic feet.

Water--Forestland is a source of good quality water. Precipitation falling on forestland is used by the vegetation, evaporated, stored in the soil, or leaves the watershed as streamflow. Streamflow is watershed yield. Forestland in the region yields 1.66 million acre-feet (542 billion gallons) annually, valued at \$4.1 million.

Forage--There is very little grazing of livestock on forestland. Because of the urban nature of the region, it is unlikely that grazing will ever be an important use of forestland.

Wildlife--Forestland is valuable wildlife habitat. Each 100 acres of well managed eastern hardwood forest can support a fall population of: three turkey, three deer, 25 grouse, 50 rabbit, and 100 squirrel for a total of 180 game animals and over 200 fur animals.

Recreation--Recreational activities can be divided into two broad categories, general and specific. General recreation includes activities attractive to the majority of outdoor recreationists and which generally require the development and maintenance of convenient access and adequate facilities. Activities include picnicking, swimming, sightseeing, camping, and hiking.

Special recreation includes activities for which opportunities, in general, are limited, intensity of use is low, and often a large personal expense is incurred by the user. Activities include hunting, fishing, backpack camping, canoeing, and snowmobiling.

There are approximately 3.87 million visitor days of general recreation use on forestland valued at \$7.7 million and 6.74 million visitor days of special recreation valued at \$32.9 million annually within the Coastal Region.

Current Growth

The forest resource in the Coastal Region is underutilized in terms of its potential to produce wood products. The usual measure of this is the growth-cut relationship. Growth is the volume of wood added annually to the inventory of wood, and cut is the volume of wood cut annually from the inventory.

Growth averages about 50 cubic feet per acre annually while the cut for wood products averages about 5 cubic feet per acre annually. The growth to product cut ratio of 10:1 indicates that the cut could be increased substantially without touching the inventory base.

The growth-cut ratio does not reveal necessary factors about the resource such as quality of wood, the economic availability of wood, the volume of wood cut but not used for products, and the volume of wood offered for sale by the landowner. The critical factor appears to be that only 50 percent of the forest land is available for wood products. Chapter 5 discusses land ownership and landowner attitudes in more detail.

Employment and Income in Primary and Secondary Wood Processing

The primary forest product industry - those companies manufacturing wood products from logs and bolts - is almost exclusively made up of sawmills. No pulp, cooperage, or veneer industries operate in the region. Excluded here are companies or individuals manufacturing fuelwood from logs and

bolts. In 1975, 33 commercial sawmills were located in the region. To supply mills with logs and bolts, 29 logging contractors were located in the region.

In 1975, approximately 100 people were employed in the sawmill industry. Employee earnings in the sawmill industry are estimated at \$700,000.

The secondary forest product industries--those companies using wood which has undergone some previous manufacturing process and which use wood exclusively or partially in a further manufacturing process, is quite extensive in the region. These industries include such diversified manufacturing processes as hardwood dimension and flooring, millwork, structural wood members, wood boxes and shooks, wood furniture, paper, and paperboard. In 1975, approximately 5,000 people were employed in these wood-based industries. Employee earnings in these industries are estimated at \$5 million.

Employment in wood-based industries is shown in Table 4.7.

TABLE 4.7 - EMPLOYMENT IN WOOD-BASED INDUSTRIES, 1974-75

Major Group	Employees
24 - Lumber and Wood Products, except Furniture	2,000
25 - Furniture and Fixtures	1,000
26 - Paper and Allied Products	2,000

Economic Factors Affecting Forest Resource

Forest land is a part of a finite land base. Changes to the land base affect the forest resource. These changes could add or subtract acreages to the forest land base, could increase or decrease the desired species composition, age and size classes of the forest stand, and increase or decrease the economic and environmental benefits derived from the forest resource. An estimated 5,000 acres of forestland has been converted annually to other land uses, primarily urban land uses.

The Coastal Region still boasts an extensive forest resource despite the pressures of a large population, and the attendant large-scale street, road, and highway network; and residential, commercial, and industrial development. The fact that forested land occupies fifty-four percent of the land area speaks well for the potential to make more complete use of the forest resource and the benefits that the forest resource can provide.

The Coastal Region by nature of the metropolitan character is not conducive to forest management as the term commonly implies. The high population density; the high level of development to support the population; the thousands of owners, most of whom own small acreages; the scattered ownership pattern; the diversity of owners' attitudes toward forest property; and the lack of diversified markets for wood products, singly and in combination inhibit an efficient forest management program.

Land to remain in forest cannot effectively compete with land that is to be developed for other more economically advantaged uses. Similarly, the use of forest land for the traditional output of commercial wood products cannot compete effectively with the desires and needs of the people for their own solitude, well being, or for whatever nonmonetary reasons they own forest land.

4.4 OTHER SIGNIFICANT ECONOMIC SITUATIONS

A. Tourism

In 1974, tourism in Massachusetts generated over \$1.15 billion and contributed approximately 3.5 percent of the total income received in the Commonwealth from all sources. Employment in the tourism industry amounted to more than 74,400 year-round jobs.

A report entitled "The Economic Impact of Tourism on the Commonwealth of Massachusetts" stated that: "there is probably no industry of any consequence to the Commonwealth - and certainly none as important as the tourism industry - about which so little is known." There are a number of possible reasons for this lack of information:

1. It is an industry with a very large number of enterprises - from giant hotels to part-time, one-person businesses;

2. customers are not easily identifiable, yet amount to some 33 million per year;
3. it is an industry whose product is service, not commodity;
4. it is an industry whose services are vastly diverse.

The report noted a rather interesting phenomenon concerning whether other New England states are competitive with Massachusetts or if the region as a whole attracts the people. If the latter is the case, then the relationship of the New England states could be considered supportive, not competitive. The report concluded that visitors tend not to come to both--visitors generally come to Massachusetts or to one or more of the other New England states.

Although the report is a preliminary study, a table of total income generated by tourism in Massachusetts was developed. Table 4.8 summarizes the findings.

Tourism plays a rather significant role in the economy of Massachusetts. If we look at the Coastal Region with its vast array of beaches, resort areas, and other tourist facilities relative to the rest of the state, it can be concluded that a rather large proportion of this total income is generated in the region. According to Professor Norman G. Cournoyer, University of Massachusetts, 1975 expenditures by non-Massachusetts travellers were \$958 million. The eastern counties of the state received nearly 92 percent of this total. Deleting Essex and Middlesex Counties,

TABLE 4.8 - TOTAL INCOME GENERATED BY TOURISM IN MASSACHUSETTS

ITEM	Accommodations					Total
	Commercial Lodging	Own Cabin, Trailer	Friends and Relatives	Other	Day Trip	
Purpose of Trip						
Business	199,381	264	38,272	4,261	12,565	254,743
Personal Business	108,456	58,321	38,059	2,581	12,305	219,723
Convention	14,622	0	106	5,330	357	20,415
Visit Friends and Relatives	70,288	2,902	192,110	22,501	15,249	303,050
Recreation, Sightseeing, Entertainment	287,992	48,935	17,785	5,186	9,981	369,879
TOTAL	680,739	110,422	286,332	39,861	50,457	1,167,809

SOURCE: The Economic Impact of Tourism on the Commonwealth, OP Cited.

NOTE: "Other" includes nights on a cruise, boat, or other special facilities.

Totals may not add, due to rounding.

the percentage drops to 71 percent. Thus, with the most conservative estimate, the Coastal Region receives nearly three-fourths of the total tourist expenditures by non-Massachusetts residents.

B. Commercial Fishing

Commercial fishing at one time was a major employer and income-earner in the Coastal Region, especially the southeast subregion. Table 4.9 summarizes the catch and value of the catch from 1930 to 1970.

TABLE 4.9 - CATCH AND VALUE, COMMERCIAL FISHING
MASSACHUSETTS, 1930-1970

Year	Catch ^{1/} (1,000 lbs.)	Value of Catch ^{2/}
1930	442,474	\$36,522,422
1940	510,938	38,903,704
1950	591,188	49,837,408
1960	480,421	43,944,988
1970	282,200	41,485,507

1/ Includes haddock, Atlantic Ocean perch, sea herring, cod, flounder, and northern lobster.

2/ Adjusted to constant 1967 wholesale dollars.

SOURCE: New England Economic Almanac, Federal Reserve Bank of Boston, (Boston: 1971). p. 26.

As Table 4.9 shows, there has been a steady increase in the unit value of the catch while the weight of the catch has decreased precipitously (41.3 percent decline since 1960). With the 200-mile ocean boundary recently

imposed by the U.S. Government, less intensive fishing by foreign flag ships has resulted in an increased catch for domestic ships.

4.5 RELATIONSHIP BETWEEN ECONOMIC SITUATIONS AND NED SPECIFIC COMPONENTS

A. Study Concern--Land Use

The NED specific components are formulated so that agricultural land moving into other uses will be minimized. Due to the higher incomes possible from alternative employments, agricultural land is decreasing because of low returns to the agricultural enterprise. This is a result of interregional competition, land prices, tenure and land holding philosophies, physical characteristics of the land (soils, slopes, growing season length, etc.), and marketing and processing infrastructure. It is obvious that a laissez-faire market policy is not conducive to the maintenance of agricultural land. Thus, a public policy which would either artificially (subsidize) or directly impact the agricultural market structure is necessary, if a viable agricultural sector is to be retained. To that end, the General Court of Massachusetts passed a development rights bill to enable local governments to purchase development rights to agricultural land and later passed a measure establishing a state program to acquire these rights. These programs could potentially lower entry costs and tax costs, and change tenure and land holding to philosophies that are more conducive to agricultural operations. The long term application of these programs, if adequately funded, should enhance the potential for economic growth of the agricultural marketing and processing infrastructure.

In discussing the forestland situation with respect to its NED specific components, similar economic conditions preclude optimism for obtaining objectives. Like the agricultural land resource area, the forestland area suffers from some adverse economic conditions which are due to interregional competition; tenure and land size holding patterns; reasons/philosophies for owning forestland; and minimal availability of primary, secondary, and tertiary wood processing firms. In addition, the dearth of economic return and cost information inhibits the development of a management program justified on economic grounds. Thus, to attain the NED specific component of increased utilization of the forest resource, requires that an approach be formulated, whereby forestland owners can see the "value" of increasing the utilization of the forestland resource.

B. Study Concern--Inland Flooding

The specific NED components with respect to the flooding study concern involve the minimizing of flood damage in the region and accomplishes the objectives by structural measures, flood proofing existing property, guiding development away from flood prone areas, and protecting wetland flood storage areas from filling or development. With respect to the present economic situation and the NED components, given the present enactments of both federal and state statutes, the attainment of the components is, from an economic point of view, quite realistic.

C. Study Concern--Wetlands

The NED components for the wetland resource area consists of protecting wetland flood storage from filling, protecting flood prone areas from development, and increasing wetland recreation as the NED components. Like flooding, given present local, state and federal enactments, the present economic conditions do not appear to preclude attainment of those components.

D. Study Concern--Recreation

According to the state outdoor recreation report, the demand for recreational needs exceeds the available supply and, thus, the NED specific component is to increase public access to outdoor recreation resources, and to increase the recreational opportunities so that the divergence between supply and demand will be minimized. From an economic perspective, attaining the NED components is not an unwarranted goal. Obviously, if present state financial problems were to continue to exist at the level of the last 3 years, the attainment would be slow. Thus, economically, the state of local and state finances will determine what proportions of the components are attained. A statute limits liability to those landowners who permit public access to their land for recreational use. The question comes to how much can the state afford to budget towards attaining the recreation objective.

4.6 ENVIRONMENTAL SITUATION

A. Coastline and Tidewater

One of the most important natural resources of the Coastal Region is the nearly 1,200 miles of saltwater shoreline. The Massachusetts coast is a study in varied contrasts. The northernmost area near the Rowley and Ipswich Rivers estuaries is an enormous tidal flat which is excellent wildlife habitat and site of the Parker River National Wildlife Refuge. Further south, the names Rockport and Marblehead evoke visions of this rugged

rockbound section of shore. South of this, Massachusetts Bay has a shoreline which is dominated by urban development which ends right at the water's edge behind sea walls, jetties, and the busy waterfront of Boston Harbor. The area from Scituate to the Cape Cod Canal is best typified by its towering cliffs of silt and sand, which sometimes slide into the sea with disastrous results for the development which stands atop the cliffs. The area inside the "arm" of Cape Cod boasts a fairly flat topography with some areas having a horizontal tidal range of over a half-mile. The outside arm of the Cape is subject to the undiminished fury of the North Atlantic Ocean. Severe storms and constant pounding by the waves result in a large movement of sand material from some areas and the building up of other areas. The South Shore of Cape Cod has some of the most densely developed residential areas on the Cape. This is a section which has an exposure to the ocean but benefits to some extent from the sheltering influence of Martha's Vineyard and Nantucket Islands. The coastline ringing Buzzards Bay is packed with coves, bays, and inlets which have been developed by people seeking a water view. The orientation and configuration of Buzzards Bay funnels the effects of hurricane-driven tides, and high water over 16 feet above mean sea level is not unheard of in this area. The coastline of the offshore islands consists of sandy beaches and high cliffs, the most famous being the fragile Gay Head cliffs at the western edge of Martha's Vineyard. The islands have a number of quaint harbors which seem to add to the natural beauty of the region.

An active program is underway, directed by the Massachusetts Office of Coastal Zone Management (CZM), to inventory, assess, and protect the coastal

resources of the state. The CZM program has benefited from the inputs of a large number of citizens. Each community along the coast has a representative to CZM. There have been some problems with communities being reluctant to give up their "home rule" for the greater good of the region, but overall, the CZM program seems to be successful in eliciting the concerns of the people in the area regarding their desires for the future management of the coast.

Preliminary findings of the CZM inventories indicate an overwhelming desire to preserve the coastal area as a region of natural beauty. Some of the most serious problems perceived by local representatives include the possibility of oil spills endangering fish, wildlife, and the tourist industry; unsightly shoreline development including shoddy beach cottages, oil tank farms, and garish commercial development; uncontrolled growth which threatens to destroy the quaint charm of the region; and on the Cape and Islands, the boom or bust nature of the important tourist industry. Overall, throughout the Coastal Zone, there seems to be an awareness of the importance of protecting the environmental factors which make the area unique, pleasant, and upon which the economy of much of the area is based.

B. Land

Landforms in the region are a result of the geologic history of the area. Glacial activity during the Pleistocene ice age was the prime factor in shaping the Coastal Region as it is today. The low rolling hills, streams

with flat gradient, and the abundance of wetland areas can all be attributed to the influence of the last glacial period. The topography of the area is, of course, one of the most important factors in the economy of the region. Tourists by the millions are attracted to the natural beauty of the Massachusetts seacoast. The appeal of Cape Cod and the offshore islands draws visitors from widely dispersed areas of the country. The quaint charm of small village centers is often overshadowed by the natural beauty influenced by the juxtaposition of land masses, wetlands, and the land-sea interface.

Topography has also been an important determinant of location for one of the most important agricultural commodities in the state--the cranberry. The shiny red berry is one of the few agricultural commodities of which Massachusetts is a net exporter in large quantities. Cranberry culture requires a combination of climate and topography which are merged in the southern portion of the Coastal Region. The many wetland areas left by glacial activity were natural choices for enhancement for cranberry growing. The abundance of groundwater and the wetland areas that could be managed for agricultural water storage further increased the potential of the area. The well-maintained bogs with their seasonal changes in vegetative characteristics have added greatly to the aesthetic and visual quality of the region. Another related function which the bogs have served is to keep significant amounts of land area as open space, rather than forest or brush land. This has resulted in keeping the landscape varied and visually interesting.

The region's wetlands have also been a source of enjoyment to residents and visitors. The area has over 159,500 acres of inland wetlands which provide storage for floodwaters, maintain summer flows in the streams, serve as fish and wildlife habitat, and enhance visual quality. In the 1960s, residents and government began to realize that wetlands were being lost at an alarming rate. Developers were buying parcels of cheap swampland, hauling in fill and constructing shopping centers and housing tracts, and then departing to let the new owners be confronted with the problems of highwater tables, settling and cracking foundations, failing septic systems, periodic flooding, and a host of related nuisances. In addition, it became apparent that loss of natural flood storage in the wetlands was causing downstream flood peaks to increase, resulting in increased financial losses due to flooding. The loss of wetland wildlife habitat and its effect on certain species was not as dramatic as the other problems but was very real to knowledgeable observers.

In some cases, town governments themselves were unwitting coconspirators in the loss of wetlands. Zoning regulations encouraged developers to build in many wetlands zoned for industrial or commercial uses. Some towns decided that these "useless swamps" would serve as good municipal dump sites. Similar problems with wetland losses occurred in the salt-water wetland areas. There, fill was being placed in prime wildlife breeding areas to provide more high value real estate.

To counter the loss of wetlands, pioneer legislation was introduced by Representative Francis Hatch. Even to this date, subsequent wetlands legislation is often referred to as "the Hatch Act" even though the original Hatch Act has seen many changes through the years. The various wetland restriction, control, and conservation measures now available to protect wetlands are described in detail in Chapter 5. Suffice it to say here that the last 10 years has seen a tremendous public awakening to the value of wetlands and the negative effects of their loss. It sometimes seems that the preservation of wetlands has taken on the qualities of a holy war. Wetlands with little value have been protected or acquired or restricted, merely because they fit the definition of a wetland. This is pointed out only to illustrate that public sentiment seems to be overwhelmingly in favor of keeping the wetlands we now have in the region. School children and oldsters, conservationists, and everyday people are aware of the value of wetlands and seem to support efforts to protect this resource.

C. Population Distribution and Land Use Aspects

The population within the Coastal Region was about 2,900,000 in 1975. With a total land area (excluding water and wetlands) of 1,500,693 acres, or 2,345 square miles, the population density was approximately 1,237 persons per square mile (or 1.9 persons per acre). Most of the population, as can be seen in Table 4.11, is concentrated in north and south subregions with respective population densities of 4.6 persons per acre and 1.3 persons per acre.

In discussing water and related land resources, however, simple analysis of permanent population data is not sufficient, especially for the Cape Cod subregion. As Table 4.10 shows, the seasonal population, when added to the permanent population for the Cape, more than triples the total population figure. Such increases become very significant in terms of planning for land use, water supply, and demand for public services.

TABLE 4.10 - PERMANENT AND SEASONAL POPULATION COMPARISONS,
CAPE COD STUDY AREA - 1960, 1970, and 1975

ITEM	1960	1970	1975
Permanent Population	63,710	91,760	125,800
Permanent Plus Seasonal Population	220,100	316,600	379,100
Percent Difference	345.47	345.03	301.35

When both the permanent and seasonal population are considered, the 1975 density in the Cape Cod area increases from .324 persons per acre (3.1 acres per person) to 1.34 (.75 acre per person), an increase of over four times.

Naturally, these differences in population density present different problems and objectives from an environmental standpoint. In addition, the sparsely populated towns are able to see the results of poor planning or rapid growth in neighboring high-density communities and are encouraged to guide their future growth. The Massachusetts Natural Resources Planning Program provides for local communities to inventory their present natural resources,

TABLE 4.11 - POPULATION, LAND AREA^{1/}, AND POPULATION DENSITIES

Area	1950	1960 ^{2/}	Percent Change 1950-1960	1970	Percent Change 1960-1970	1975	Percent Change 1960-1975
Northeast							
Population	1,588,530	1,606,923	1.16	1,648,453	2.58	1,634,966	-.82
Land Area (AC)	387,241	384,829	-.62	382,417	-.63	382,417	0.00
Densities							
Persons per acre	4.10	4.18	1.95	4.31	2.86	4.28	-.69
Persons per sq. mi.	2,625	2,672	1.79	2,759	2.91	2,736	-.83
Southeast							
Population	751,370	915,581	21.86	1,067,470	16.59	1,125,464	5.43
Land Area (AC)	860,816	855,334	-.64	849,853	-.64	849,853	0.00
Densities							
Persons per acre	.87	1.07	22.99	1.26	17.76	1.32	4.76
Persons per sq. mi.	559	685	22.54	804	17.37	848	5.47
Cape Cod & Islands							
Population	51,353	76,129	48.25	103,447	35.88	141,110	36.41
Land Area (AC)	355,073	353,348	-.49	351,623	-.49	351,623	0.00
Densities							
Persons per acre	.14	.22	57.14	.29	31.82	.40	37.93
Persons per sq. mi.	92.56	137.89	48.97	188.29	36.55	256.84	36.41
Total Coastal Region							
Population	2,391,253	2,598,633	8.67	2,819,370	8.49	2,901,540	2.91
Land Area (AC)	1,603,130	1,593,511	-.60	1,583,893	-.60	1,583,893	0.00
Densities							
Persons per acre	1.49	1.63	9.40	1.78	9.20	1.83	2.81
Persons per sq. mi.	955	1,044	9.32	1,139	9.10	1,172	2.90

^{1/} Land area excludes water acreage. ^{2/} Land area for 1960 extrapolated from 1950-1970 trend.
 SOURCE: Population figures from Table 2.2. Land acreage from MacConnell, et al.

to evaluate those resources against established guidelines, to determine the consequences of proposed actions on the natural resource base, and to plan the most acceptable future course of action to maintain or improve the community's selected level of environmental quality. Over half of the Massachusetts communities participating in the Massachusetts Natural Resources Planning Program are located within the Coastal Region. This indicates the relatively high interest on the part of local people in conserving their natural resources and insuring that future growth is compatible with the desired community environmental quality.

As Table 4.11 shows, the Cape Cod and Islands subregions area showed the greatest growth rates in population and population densities between 1950 and 1970. The reason for this trend is primarily because of the increase in seasonal populations. Future growth is expected at a much slower rate because of rather strong land use planning legislation that has been enacted in the last few years. Between 1970 and 1975, the northeast subregion showed an actual decline but, when it is remembered that Boston thoroughly dominates the demographic characteristics of the area, the trend excluding Boston is not atypical of the rest of the region.

It is important to note that from an environmental perspective, there are enough water and related land resources to satisfy future resource demands without resulting in the degradation of environmental quality. Such results can only be achieved, however, if future growth is guided away from environmentally sensitive areas to those locations which can adequately accommodate

future developments. Also required is an enactment of means, whereby desirable growth is permitted. For example, most agricultural and forested land in the region is zoned "low density residential." Such zoning results in extensive developments which consume large acreage and also provide the vehicle for urban sprawl and increased service requirements. Therefore, if a regional goal is to preserve agricultural land, and if zoning ordinances are not modified to permit more intensive uses of land (e.g., cluster developments, planned unit developments, etc.), it is doubtful whether preservation goals can be attained.

Although the region supports a large population, significant portions of Plymouth and Bristol Counties can still be classified as predominantly rural with the important agricultural activities being dairying and cranberry culture. The area immediately south of the Boston metro area is suburban. The area to the north is best described as suburban with a small amount of farming mainly utilized for truck gardens and nursery stock enterprises. The environmental setting on Cape Cod and the Islands is a specialized situation geared to the enjoyment of the year-round residents and the thousands of summer visitors. Development on the Cape and Islands is concentrated in village centers, with additional scattered construction which appears to blend with the natural setting. Major agricultural enterprises include cranberry and vegetable production.

Agriculture, although not a predominant land use, ranks as an important factor in the economy, especially in Bristol and Plymouth Counties. Besides the economic value of farming in the region, another very important

contribution comes from the aesthetically pleasing open space being created and maintained by farming. Pastures with grazing cattle, the neat rows of growing vegetables, and the expanses of colorful and interesting cranberry bogs all add to the visual quality of the area. In addition, the active management of these areas prevents them from reverting to forest vegetation, which is so common as to become monotonous at times.

There appears to be a growing realization on the part of the public as to the importance of maintaining farmland in production. One of the phases of this Massachusetts Water Resources Study has investigated the economic viability of farming in Massachusetts. Aside from the economic value of agriculture, the aesthetic values and the beneficial effects upon the environment are gaining greater recognition among the public and in state government. A bill has passed the legislature to authorize purchase of development rights on farmland to encourage continued agriculture use to benefit both food supplies and the environment. Several communities are investigating local programs to encourage and maintain agriculture. The Horticultural Land Assessment Act is another example of the state's efforts to retain an agricultural base for its many benefits.

D. Inland Water

The Coastal Region has over 51,900 acres of fresh open water, in addition to the 159,500-acres of inland wetlands. There are about 550 miles of major streams and tributaries.

Because of the flat topography, most of the streams and rivers are rather sluggish when compared to streams in the rest of Massachusetts. The flat gradient and tremendous wetland areas result in flood flows which are much lower than those experienced in other parts of the state. The slow movement of water through the stream system has also resulted in compounding water quality problems. Atmospheric reaeration and the resulting increase in dissolved oxygen is low because of low water velocities and associated low turbulence. Decaying organic material in wetland areas has also served, in some cases, to decrease the dissolved oxygen content and to give an undesirable color to the water.

The flat topography has also meant that most of the surface water reservoirs which have been built have relatively shallow ponds (less than 30 feet deep). In most cases, this is because the height of the dam was limited by the height of the natural abutments, and the need for extensive diking to avoid inundating too large an area.

Geology, too, has played an important role in limiting the depth of surface water bodies and determining the source of public water supplies. In the northern portion of the region, bedrock is relatively close to the ground surface and leakage through abutments and foundations of reservoirs can be controlled. However, in the southern portion, sand and gravel deposits are quite deep and leakage becomes a problem. On Cape Cod and the Islands, where sand deposits can be hundreds of feet deep, most ponds are natural depressions with a water level maintained at about the level of the sur-

rounding water table. The exceptions on the Cape and Islands are ponds with one or two feet of flashboards used to raise the water level slightly above the groundwater level.

These geologic differences within the region have resulted in towns in the northern section relying on a combination of groundwater and some reservoirs of significant depth. In the southern section, groundwater becomes the predominant municipal water source with only 40 percent of the towns utilizing a combination of surface sources and groundwater, and only 11 percent using surface supplies only. On the Cape and Islands, municipal supply is entirely from groundwater, with the exception of Falmouth which uses a combination of groundwater and surface supply.

The topography and geology place some obvious restraints on future planning for water supply and recreation. There are some opportunities for new surface reservoirs, but they are limited.

4.7 PROJECTIONS

A. General Methodology

A major objective of the Massachusetts Water Resources Study (MWRS) is to project a number of important variables (land use, population, income, etc.) and, thereby, identify areas that may experience potential

problems. Once potential problems are recognized, alternative policies can then be developed which have as their objective the minimization of any such problems.

As the Southeastern New England (SENE) River Basin Study pointed out, the growth of a region and the quality and quantity of its water and related land resources are closely interrelated. New development creates demand for water (drinking, recreation, waste disposal) and also consumes land and may result in an encroachment upon ecologically and economically sensitive areas (e.g., flood plains, wetlands, and lands overlying aquifers). Projections are utilized to determine the extent and rate of development and whether increased demands on the resource base can be met with a set of projected resource supplies (water, land, transportation, etc.). Problems arise when critical resources of a minimum quality and quantity cannot satisfy such demand. For example, federal and state land use policies have placed a priority on the preservation of agricultural land (specifically, prime agricultural land). In the past, much of the development in the region has been at the expense of forest and agricultural land. Given the priorities on preserving such land, future growth and the demand for land give an indication of what is likely to occur, given recent trends. Such forward looking procedures also indicate the extent to which future growth must be guided.

B. Population Projections

The current and projected population figures were taken from material developed by the planning organizations located in the Coastal Region. These figures were utilized, rather than the OBERS figures, for the following reasons:

1. The geographic configuration of the region presents many difficulties in accurately allocating various OBERS SMSA population data to the region.
2. OBERS projections were developed, using 1972 data, whereas the planning commissions used more current information and trends.
3. National projections are disaggregated first to states, then regions, and finally to subregions. For each disaggregation, the probability of error increases correspondingly.
4. The Massachusetts Office of State Planning (OSP) has required that population projections for any particular planning region be based on a consistent methodology which was developed by OSP. This methodology differs from that used in the 1972 OBERS projections.

Population projections from the regional planning and development commissions show population increasing through 1990. By 1980, population is expected to be 3,072,250 people, an increase of 252,850 or nearly 9 percent greater than the 1970 population. When seasonal 1980 projections are included, a total increase of 500,000 is expected (a 17.7 percent gain). The 1990 projections show an increase of 389,800 (with seasonal population, 750,000) people over 1970, or an increase of 14 percent (with seasonal population included, 27 percent).

C. Land Use Projections

A number of methodologies were utilized to project land use categories to 1990. The categories are:

1. Agricultural Land
 - a. Total cropland
 - (1) Harvested cropland
 - (2) Pasture/grazing cropland
 - (3) All other cropland
 - b. Woodland
 - c. All other farmland
 - d. Total land in farms
2. Urban Land
 - a. Industrial land
 - b. Commercial land
 - c. Institutional land
 - d. Residential land
3. Open Water Areas
4. Wetlands
5. Forestland
6. All Other Land

Agricultural land was projected by using historical agricultural census land use data which was weighted heavier in the latter years of the data (1964, 1969, 1974) to reflect the more recent trends. Since agricultural census data is delineated on a county basis, it was necessary to allocate data from those counties which are located in more than one study region. The allocation was accomplished by using MacConnell's land use data to determine the amount of agricultural land by town in each region. These proportions were formulated and used to adjust the county census data to

reflect that data which is derived from the Coastal Region. Once the adjusted census data was enumerated for each subregion, a Markov probability program was used to project the 1990 shares by agricultural land use category. The OBERS total agricultural land projection was used to compute the 1990 land and farms acreage. From the Markov probability program, a set of proportions for each agricultural land use category was determined for 1990. These proportions were then multiplied times the OBERS total land in farms figure to derive 1990 projected acreage by agricultural land use category.

The projected change from 1975 to 1990 suggests that a 4.2-percent decline will occur on total land in farms (a decline of 6,574 acres). Looking at the subcategories of agricultural land, the projections suggest that pasture/grazing cropland and all other cropland will increase (the former by 6.5 percent - 650 acres, and the latter by 21.3 percent - 677 acres). The sharpest decline occurs in the category all other land in farms from 38,344 acres in 1975 to 33,880 acres in 1990, representing a decline of 4,464 acres, or 11.6 percent. Harvested cropland is projected to decline by 7.7 percent, or from 42,763 acres in 1975 to 39,466 acres in 1990.

Urban land was projected by using historical land use data developed by William P. MacConnell, University of Massachusetts. Utilizing this data, plus residential population projections for 1990 as supplied by the planning agencies in the region, a log-linear regression model was used to

fit urban land shares to population density by town. A number of different regression models were run, but the population density model together with historical urban land acreage was found to fit the best.

Base year data for 1950 and 1970 was used to estimate the regression coefficients for the entire Coastal Region. Similar regressions were also calibrated by subregions to reveal regional differences. Weighted aggregations of these coefficients by region and subregion for 1950 and 1970 were used in the final regression model to predict or project urban land use by subregion for 1990. With the limited data (1950, 1970), this model is very efficient, relative to larger land use models, for it makes use of minimal data requirements. Population projections were not complete for the Cape Cod and Islands subregions. For that reason, the total projected urban land may be somewhat understated. The projected urban land area for the entire Coastal Region is expected to amount to 393,567 acres by 1990. With respect to the subregions, the following projections are noted: northeast - 143,498; southeast - 190,437; and Cape Cod and Islands - 59,732. The percent changes between 1970 and 1990 amount to 10.65 percent in the northeast, 17.86 percent in the southeast, and 23.93 percent in Cape Cod and Islands. Translating these percentages to the Coastal Region area results in a 15.97-percent increase of 54,191 acres in urban land by 1990. Thus, where in 1970, urban land was approximately 20.2 percent of the total coastal area, by 1990 it is expected to amount to 23.4 percent. The 1990 projections for open water area is expected to remain approximately

the same as the 1970 figure of 95,847 acres. This figure may understate the total expected open water, because there is one Public Law-566 Water Impoundment Project presently being constructed in the region. However, the additional acreage is minimal.

Wetland acreage was projected, using historical trend analysis in conjunction with the impact of wetland preservation enactments. Almost all of the wetland acreage data were developed by the Soil Conservation Service. From this data, the 1976 wetland acreage in the Coastal Region was determined. There were three major subcategories in wetland land use: open, wooded, and salt marsh. From analyzing historical trends and adjusting such trends to reflect wetland preservation regulations, it was determined that the average annual decrease in wetland acreage through 1990 from open and wooded wetlands (not salt marsh) would be .4 percent. MacConnell's 1970 wetland acreage figure (83,200 acres) is an aggregation of both salt marsh and open type wetland. In order to accurately reflect possible or potential forestland decreases, it was necessary to separate out that forestland which was in fact wetland. An assumption was made that the salt marsh acreage and the open type wetland acreage were of the same proportion in 1970 as they were in 1976 (i.e., the proportion reflected in the 1976 Soil Conservation Service data). It was also assumed that wooded swamp land was also in similar proportions to the total open and salt marsh wetlands. It was necessary to derive a total wetland figure for 1970, so that adjusted historical rates of decline would equal the 1976 SCS data of 200,231 acres. The 1970 wooded wetland was computed to be 120,938

acres and that, when summed to the 83,200-acres of open and salt marsh land, equals 204,138 total acres of wetland for 1970.

MacConnell's 1970 forestland acreage was adjusted downward by subtracting the wooded swamp acreage determined above, and woodland on farms. These two categories were subtracted from MacConnell's data, because trend analysis reflected differing rates of decline for each of the wooded wetland and the woodland on farms. Also, since woodland on farms is included in the agricultural land category, including it in the forestland category would result in double counting. Once the adjustments were accomplished, the 1970 forestland acreage was adjusted from 908,000 acres to 722,370 acres. Trend analysis was then used to project forestland to 1990.

The final land use category--"other" land use was projected as the residual from the above land use categories.

Table 4.14 summarizes the 1990 land use projections.

TABLE 4.14 -- 1990 LAND USE PROJECTIONS AND CHANGES, 1975-1990

ITEM	1990 Acreage	1975 Acreage	Change	Percent Change
Total Agricultural Land ^{1/}	149,777	156,351	- 6,574	- 4.2
Total Cropland	53,919	55,889	- 1,970	- 3.5
Harvested cropland	39,466	42,763	- 3,297	- 7.7
Pasture/grazing cropland	10,604	9,954	+ 650	+ 6.5
All other cropland	3,849	3,172	+ 677	+21.3
Woodland on farms	61,978	62,117	- 139	- 0.2
All other farmland	33,880	38,344	- 4,464	-11.6
Urban Land	393,567	339,376	+54,191	+16.0
Water	95,847	95,847	--	--
Wetlands	191,301	204,138	-12,837	-6.2
Forestland ^{2/}	689,858	722,370	-32,512	- 4.5
All Other Land	159,450	139,875	+19,575	+14.0

1/ Agricultural acreage for 1974; other from 1971.

2/ Excludes wooded wetlands and woodland on farms.

D. Economic Projections

As Section 4.1 discussed, the Coastal Region has progressed through three economic periods. Projections to 1990 suggest a continuing of the latest trend--increased employment and earnings in the service-related industries relative to the manufacturing sector. The economic projections, summarized in Table 4.12, were formulated using OBERS Series E projections, gathered for the Boston and New Bedford-Fall River SMSAs, and then combined to illustrate economic trends in the region. There is a slight shortcoming in extrapolating the data to the whole Coastal Region, in that the two regions do not geographically overlap. However, in this study, the direction and velocity of identifiable trends are more relevant considerations than the absolute numbers. In this light, the fact that there is not an exact geographical parallelism, does not detract from the validity of the analysis.

From Table 4.2, there was an increase in manufacturing earnings of \$1.4 billion between 1950 and 1970, or nearly 68 percent. At the same time, there was an increase in service-related industries (finance, insurance, real estate, services, government) of \$3.5 billion during the same period resulting in an increase of 185 percent. From Table 4.12, the respective increases for the 20-year period between 1970 and 1990 are:

1. Manufacturing earnings = \$2.0 billion, or 57 percent;
2. service-related earnings = \$8.3 billion, or 153 percent.

Total earnings are expected to increase by nearly \$14 billion, or 108 percent gain.

In reference to the objectives of this study, the question must be asked how will or how might the expected economic and social trends affect the region's water and related land resources? This question can be answered by determining what new demands will be placed on these resources. The SENE study concluded optimistically:

Demographic and land use studies showed rather conclusively that for the foreseeable future the overall growth in the SENE Region is clearly not limited by the region's water and related land resources. There is enough space (....) to accommodate all growth to 2020 even at the spectacular high rate of land consumption of the last decade. Growth can be accomodated but it needs guidance.

In other words, with proper land use guidance, the overall growth, both economic and social, should not adversely impact upon the region's water and related resources.

TABLE 4.12 - POPULATION, EMPLOYMENT, PERSONAL INCOME, AND EARNINGS
BY INDUSTRY, HISTORICAL AND PROJECTED, SELECTED YEARS, 1962-1990

ITEM	Historical		Projected	
	1962	1970	1980	1990
Population, midyear	3,838,982	4,160,187	4,577,800	5,046,700
Per capita income (1967 dollars)	2,952	3,958	5,446	6,957
Total employment	1,500,971 ^{1/}	1,723,537	2,097,900	2,318,400
Employment/population ratio	.39	.41	.46	.46
-----In Thousands of 1967 Dollars-----				
Total personal income	11,331,659	16,464,485	24,931,500	35,109,800
Total earnings	9,203,213	12,967,402	19,307,600	26,963,600
Agriculture, forestry and fisheries ^{4/}	70,837 ^{2/}	62,260 ^{2/}	87,400	97,200
Agriculture			62,900	66,900
Mining ^{4/}	3,469 ^{3/}	4,044 ^{3/}	24,400	30,200
Nonmetallic, except fuel			7,500	8,900
Contract construction	509,735	824,967	7,500	8,900
Manufacturing ^{4/}	2,961,606	3,521,467	1,216,500	1,636,300
Food and kindred products			4,504,200	5,534,300
Textile mill products			266,700	312,200
Apparel and other fabric products			129,300	116,100
Lumber products and furniture			226,500	236,000
Paper and allied products			60,100	68,800
Printing and publishing			157,700	188,800
Chemicals and allied products			344,600	451,600
Petroleum refining			164,100	227,700
Primary metals			8,700	9,600
Fabricated metals and ordnance			74,000	77,700
Machinery (excl. elec.)			441,500	598,300
Electrical machinery and supplies			560,500	683,600
Motor vehicles and equipment			850,800	1,039,200
Transportation equipment (excl. motor vehicles)			64,900	80,200
Other manufacturing			198,600	228,400
Transportation, Communications, and public utilities ^{4/}	605,234	845,583	953,800	1,214,700
Railroad transportation			1,285,200	1,807,500
Trucking and warehousing			46,000	46,200
Other transportation and services			319,300	452,800
Communications			302,000	405,700
Utilities (electricity, gas, sanitary)			430,400	652,000
Wholesale and retail trade	1,681,912	2,284,519	187,000	250,500
Finance, insurance, and real estate	607,683	878,114	3,210,800	4,183,400
Services ^{4/}	1,496,407	2,654,897	1,374,600	1,949,200
Lodging places and personal services			4,808,700	7,625,800
Business and repair services			222,600	264,200
Amusement and recreational services			990,900	1,581,100
Private households			92,200	123,700
Professional services			72,100	76,000
Government	1,257,468	1,873,116	3,430,500	5,580,500
Federal government	365,640	484,528	2,812,100	4,119,900
State and local government	730,922	1,195,718	650,400	901,100
Armed forces	160,906	192,875	1,968,400	2,973,000
			192,900	245,700

1/ Employment is for 1960.

2/ Represents 80.0 to 99.9 percent of the true value.

3/ Represents 60.0 to 79.9 percent of the true value.

4/ Historical data for subcategories were deleted from the OBERS report, Volume 5.

SOURCE: 1972 OBERS Projections, Economic Activity in the U.S., Volume 5, Standard Metropolitan Statistical Areas, Series E., pp. 40 and 79.

The economic projections are based upon the assumptions set forth in the OBERS Report. If these assumptions are shown to be invalid for a particular region, the projections as presented would need to be adjusted accordingly.

E. Wood Products Projections

The tabulation derived from OBERS presents estimates on the projected potential of wood product production in the Coastal Region through 1990. The projected potential, although used for the analysis in this report is somewhat artificial, for it is based on area of forest land and productivity and does not account for the availability of forest land. It is used only as a benchmark in the analysis.

<u>Year</u>	<u>Millions of Cubic Feet</u>
1980	8.2
1990	9.2

F. Outdoor Recreation Projections

Projected demand for water-based and water-related outdoor recreation activities in 1990 have been obtained from adjusted demand figures from the 1976 Statewide Comprehensive Outdoor Recreation Plan (SCORP) and presented in Table 4.13.

TABLE 4.13 - PROJECTED 1990 RECREATION DEMAND

<u>Activity</u>	<u>Demand</u> <u>(1,000 Activity Days)</u>
Swimming	45,298
Camping	3,269
Picnicking	15,573
Canoeing-Sailing	6,468
Hiking	10,793

CHAPTER 5 - RESOURCE BASE AND EXISTING PROGRAMS

5.1 GENERAL

The Coastal Region includes approximately 2,600 square miles and is composed of many small independent watersheds which flow directly into the Atlantic Ocean. Unlike the Connecticut River Basin, the Coastal Region is not united by a single great river. The Taunton River Watershed forms the largest area drained by a single river in the region.

Major streams within the Coastal Region are shown below:

<u>Subregion</u>	<u>Study Area</u>	<u>Major Streams</u>
Northeast	Parker Ipswich North Shore	Parker River Ipswich River Saugus River Mystic River
	Neponset	Neponset River
Southeast	South Shore Taunton Buzzards Bay	North River Taunton River Agawam River Weweantic River Westport River
	Narragansett Bay	Ten Mile River Palmer River
Cape Cod	Cape Cod	Bass River Herring River
	Islands	-

All of these streams listed drain directly into tidewater. The Charles River is not included here, as the MWRS work on the Charles River was done in coordination with the Corps of Engineers' Implementation Study completed in 1972.

The Coastal Region consists of 127 cities and towns: 47 in the northeast, 57 in the southeast, and the 23 towns of Cape Cod and the Islands. Plymouth, Bristol, Barnstable, Dukes, Nantucket, and Suffolk Counties are entirely within the region. Portions of Middlesex, Essex, and Norfolk Counties are also within the region.

Region boundaries were originally selected, based on the hydrologic watershed boundaries as being natural dividing lines, for a study of water and related land resources. Because of the importance of municipal governments in planning and implementing measures in Massachusetts, it was decided to adjust the hydrologic region boundaries so that all of a town's area could be assigned to one region. The towns which were included in the Coastal Region are indicated on Figure 5.1.

Although the region is dominated by the urbanized Boston Metropolitan Area and by smaller urban centers of Brockton, Fall River, Lawrence, Haverhill, and New Bedford, there is still rural and undeveloped land. While population densities range as high as 21,600 persons per square mile in Somerville, next to Boston, there are 13 towns with population densities of less than 100 persons per square mile. The lowest density in the region is in the island town of Gosnold, with 6 persons per square mile.

A. Soils

The soils of the Coastal Region have formed in materials influenced by glaciation. The region's many upland hills and ridges are mantled with two or three feet of friable, loamy or sandy material underlain by firm or friable, loamy or sandy, heterogenous glacial till. Stones and boulders are normal surface features in wooded areas. Bedrock outcrops are common, especially on steeper slopes.

Intermingled with the uplands, in valleys and lower positions and on relatively broad plains, are soils formed in materials influenced by glacial meltwater. Slopes in these areas range from nearly level to moderately steep. The soils are quite varied, but all have substrata of sand or sand and gravel. The surface soil and subsoil portions may be silty, loamy or sandy and contain varying amounts of gravel.

Minor areas in the extreme northern and eastern parts of the region and the extremities of the Cape and Islands include Beaches, Tidal marshes, Sand dunes and soils formed in glacial lakebeds.

The general soil map for the Coastal Region is on Figure 5.2. Fourteen broad associations are recognized. For the purposes of convenience and discussion, the associations are grouped into five larger sections based on the type of material in which each formed.

Soils formed dominantly in dense firm glacial till:

1. Paxton-Hollis-Canton association

These fine sandy loam soils are on gently sloping to steep hills and ridges throughout the uplands of the northern part of the region. Stones and boulders are scattered over the surfaces of many wooded areas. Bedrock outcrops are common in some areas, particularly on the steeper slopes. These soils are well to excessively drained and are free of problems associated with soil wetness.

This association has three dominant soils. The Paxton soils have loamy, slowly permeable substrata and make up to 50 percent of the association; the shallow to bedrock Hollis soils constitute about 15 percent; and about 10 percent are the Canton soils with sandy, permeable substrata. Numerous minor soils make up about 25 percent of the association.

2. Scituate-Essex-Ridgebury association

These soils are on nearly level to moderately steep hills, ridges and upland depressions in the central part of the region.

Scattered stones and boulders are common surface features in wooded areas. The major soils have compact slowly permeable substrata. A seasonal high water table persists for a number of months in the Ridgebury soils.

Three major soils are dominant in this association. The moderately well drained Scituate soils have a sandy loam mantle over sandy substrata. They make up about 40 percent of the association. The well drained Essex soils have loamy sand subsoils and substrata. About 30 percent of the association consists of Essex soils. The poorly drained Ridgebury soils make up about 20 percent of the association. A number of minor soils constitute the remaining 10 percent.

3. Paxton-Whitman-Woodbridge association

These soils are on nearly level to moderately steep hills, ridges and upland depressions in the southwest part of the region. Stones and boulders are common surface features in wooded areas. Compact, slowly permeable substrata are common to the major soils of this association. Loamy textures are dominant in both the subsoil and substrata. The Whitman soils have a water table for about three-fourths of the year.

The three named soils are dominant in this association. The well drained Paxton soils constitute about 40 percent of the association; the wet Whitman soils about 20 percent; and Woodbridge, a moderately well drained soil, about 15 percent. Numerous other soils make up the remaining 25 percent.

Soils formed dominantly in friable glacial till:

4. Canton-Plymouth-Carver association

These soils are on undulating to hilly glacial moraine land forms in the southeast part of the region. Wooded areas have few surface stones and boulders. They are somewhat excessively or excessively drained and tend to be drouthy.

Plymouth and Carver soils have rapidly permeable sandy subsoils and substrata. Canton soils have loamy subsoils and permeable sand substrata. About 30 percent of the association is Canton, 25 percent Plymouth, and 20 percent Carver soil. The remaining 25 percent consists of numerous minor soils.

5. Gloucester-Muck-Hinckley association

This association contains soils formed in friable glacial till, water sorted glacial outwash and pockets or swales of organic deposits. These contrasting materials are intermingled in an

area in the southern part of the region. The soils in this association are on gently sloping to moderately steep uplands, nearly level flats and nearly level to undulating terraces. Wooded areas of Gloucester soils often have a few surface stones and boulders. Gloucester and Hinckley soils on gentle slopes are suited for agriculture, but they tend to be drouthy. Muck soils are too wet for most uses:

Gloucester soils make up about 50 percent, Muck about 15 percent, and Hinckley about 15 percent of this association. 20 percent consists of a number of minor soils.

6. Canton-Paxton-Merrimac association

This association consists of soils formed in glacial till as well as soils formed in water sorted glacial outwash. The contrasting materials are closely intermingled in a small area in the northern part of the region. The soils are on nearly level to undulating terraces and gently sloping to moderately steep upland ridges. They have fine sandy loam surfaces. Wooded areas of Canton and Paxton soils often have surface stones and bedrock outcrops are in some areas. The lower slopes of all these soils are suited for agriculture. They are well drained and soil wetness is not a problem.

Canton and Merrimac soils have permeable, sandy substrata. Paxton soils have compact, slowly permeable substrata. This association is composed of about 50 percent Canton soils, 20 percent Paxton soils, and 20 percent Merrimac soils. Other minor soils make up the remaining 10 percent.

7. Plymouth-Chilmark-Nantucket association

The soils in this association formed in glacial till. They are on nearly level to steep moraine land forms, primarily on the islands of Martha's Vineyard and Nantucket. These soils are well to excessively drained, and soil wetness is generally not a problem. The nearly level to sloping areas of Chilmark and Nantucket soils are suited for agriculture and many other uses.

The Plymouth soils have permeable sandy subsoils and substrata. They make up about 50 percent of the association. Chilmark and Nantucket soils have loamy subsoils and firm loamy substrata. About 15 percent of the association is Chilmark soils and 15 percent Nantucket. Other minor soils make up the remaining 20 percent.

Soils formed dominantly in water sorted glacial outwash:

8. Hinckley-Windsor-Muck association

The soils in this association formed in glacial outwash and in pockets of organic materials. They are generally in the valleys on nearly level to rolling terraces, kames, deltas and eskers. Numerous areas of this association are suited to agriculture. Many soils in this group are free of water table problems and in fact are limited by drouthiness. Muck soils, however, are too wet for most uses.

Three major soils dominate this association. The permeable Hinckley soils have sandy or sand or gravelly substrata. About 40 percent of the association are Hinckley soils. Windsor soils have very permeable, sandy substrata and make up about 30 percent of the unit. The wet organic Muck soils make up about 10 percent of the association. A number of other minor soils constitute the remaining 20 percent.

9. Hinckley-Canton-Muck association

These soils formed in glacial outwash, sandy glacial till and in pockets of organic deposits. These contrasting materials are closely intermingled in an area in the west central part of the region. The soils are on nearly level to rolling terraces and broad, gently sloping to moderately steep, upland ridges. Soil wetness is not a problem in the excessively drained Hinckley or the well drained Canton soils. The lower slopes of these soils are suited for agriculture, but there is a drouthiness problem. The Muck soils are far too wet for most uses.

Hinckley soils have sandy or sandy and gravelly subsoils and substrata. Canton soils have loamy subsoils and sandy substrata. The permeability of both these soils is rapid. The organic material of the Muck soils are waterlogged most of the year. About 40 percent of the association is Hinckley, about 30 percent is Canton, and 10 percent is Muck. A number of minor soils make up the remaining 20 percent.

10. Carver-Muck-Hinckley association

The soils in this association formed in water sorted materials, primarily glacial outwash, and in pockets of organic materials. They usually are on broad, nearly level to undulating, outwash plains in the southern part of the region. Both the Carver and Hinckley soils have a drouthiness problem when cultivated, but are suited for other uses. Muck soils are too wet for most uses.

Three major soils are dominant in this association. Both Carver and Hinckley soils have permeable sandy or sandy and gravelly subsoils and substrata. Muck soils consist of waterlogged organic materials. About 40 percent of the association is Carver, about 15 percent is Muck, and about 15 percent is Hinckley. The remaining 30 percent consists of numerous minor soils.

11. Dukes-Carver-Tidal marsh association

The soils in this association formed in water sorted and wind influenced sands and in organic deposits subject to tidal flooding. They are on nearly level to rolling land forms on the outer reaches of Cape Cod. The sandy Dukes and Carver soils retain water very poorly and are very drouthy. The wet Tidal marsh areas are flooded twice daily by the ocean tide.

About 35 percent of the association is Dukes soils, about 30 percent Carver soils, and about 15 percent is Tidal marsh. Numerous other soils make up the remaining 20 percent.

12. Evesboro-Riverhead-Katama association

These soils formed primarily in water sorted glacial outwash materials. They are on broad, nearly level to undulating, outwash plains on the southern part of the islands of Martha's Vineyard and Nantucket. The three major soils have sandy substrata, but Riverhead and Katama have sandy loam subsoils. All these soils have low capacity to retain moisture and are drouthy.

About 50 percent of the association is Evesboro, about 20 percent Riverhead, and 20 percent Katama. About 10 percent of the association consist of numerous other minor soils.

Miscellaneous areas of wind deposited sand, ocean washed beaches and tidal flooded marshes:

13. Dune land-Tidal marsh-Beaches association

This association is composed of areas of wind deposited sands and tidal flooded beaches and marshes of organic material. 15 small areas of this association are scattered along the coastlines. The sandy Dune land is primarily stabilized by beach grass and a few other plants. Beaches are chiefly sandy and barren of vegetation. The Tidal marshes are well vegetated with salt grass, but are wet and are flooded twice a day by the tidal flow.

About 50 percent of the association is Dune land, about 40 percent Tidal marsh, and 10 percent beaches.

Soils formed in glacial lakebeds:

14. Scantic-Hollis-Mayoid association

The soils in this association formed in clayey lake or marine deposits. The soils are dominantly on nearly level flats in the extreme northern part of the region. They are primarily poorly or very poorly drained, slowly permeable, clayey soils. The association is a minor part of the region. Bedrock outcrops are common in some areas. Wetness and restricted permeability are problems for most uses of these soils.

The Scantic, Hollis and Maybid soils are dominant in this association. Hollis soils are shallow to bedrock, but the other soils are deep to rock. Scantic soils make up about 40 percent of the association, Hollis soils about 20 percent, and Maybid soils 20 percent. Other minor soils comprise about 20 percent of the association.

B. Geology

Most of the region lies within the Coastal Lowland section of the New England Physiographic Province, with Cape Cod and the offshore Islands within the Coastal Plain Province. The region has a gently rolling topography and a drainage pattern consisting of a series of wetland areas interconnected by a system of streams and rivers. The topography is the result of changes induced by the glacial movements during the last ice age, over 10,000 years ago. The coastline has many interesting geologic features, such as sandy beaches and offshore bars, salt marshes, estuaries, stationary and "walking" sand dunes, and rockbound sections of coast.

Bedrock in the region includes types of igneous, metamorphic and sedimentary rock. In most areas, the bedrock is at least 10 feet from the

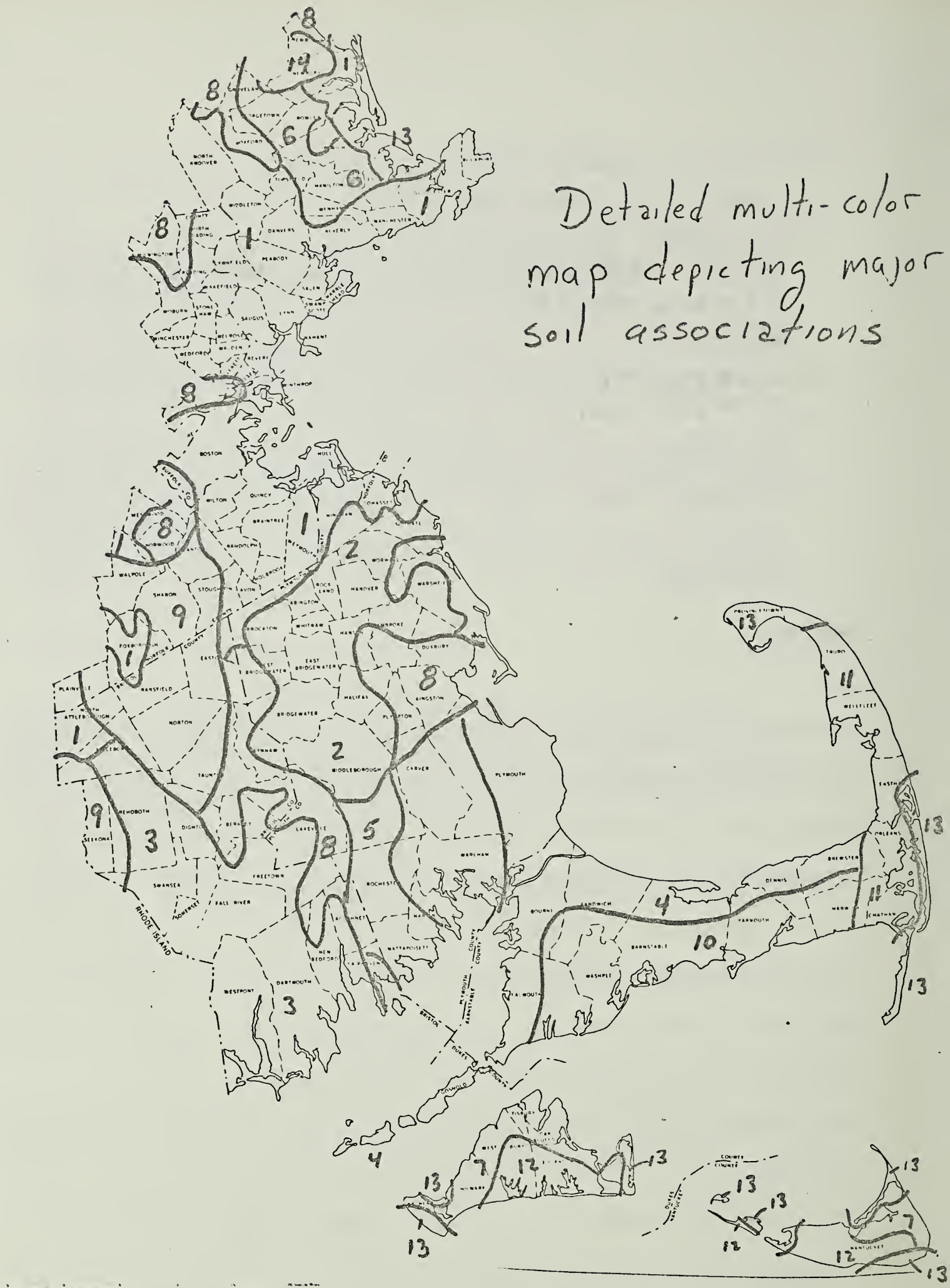


Figure 5.2
General Soils Map

surface, but rock outcrops are common in the northern half of the area. In the southern part of the region, especially on Cape Cod and the Islands, sand and clay deposits may overlay bedrock by hundreds of feet. Sedimentary rocks (conglomerates, shales, sandstone) are commonly found in the southern part of the region with the igneous and metamorphic rocks located to the north. Martha's Vineyard has the unique presence of Cretaceous coastal plain deposits outcropping at Gay Head and present throughout the western part of the island in the subsurface.

Most of the unconsolidated geologic material owes its origin to the ice age glacier, which eroded large quantities of rock and redeposited the material as dense glacial till, a mixture of silt, sand, gravel, cobbles, and boulders. As the glacier melted, large quantities of materials were loosely deposited as moraines, the most prominent being Cape Cod.

Water from the melting glacier formed streams which transported and deposited sediment as glacial outwash. The sediment was deposited in broad, flat outwash plains. Elsewhere, outwash partially filled deep valleys in the bedrock surface. Some of the waterborne sediment was deposited against remnant blocks of glacial ice. Glacial outwash and ice contact deposits are composed of sand and gravel.

Glacial meltwater was trapped in depressions or in stream valleys which were dammed by ice. Thin layers of clay, silt, and fine sand collected on the bottom of these lakes. Streams entering the lakes created deltas of sand. After the glacier had receded, the dams were breached, lakes drained, and the topography assumed its present appearance, with many wetland pockets connected by slow-moving, low-gradient streams.

C. Vegetative Cover

Approximately 80 percent of the region is in nonurban uses. Forestland is by far the most dominant, with 908,000 acres (54 percent), with agriculture, wetlands, water and other land contributing 25 percent.

With respect to forestland, hardwood forestland outnumbered softwood by approximately three to one, but the tree volume is about equally divided between softwood and hardwood species. White pine is the predominant softwood, with lesser volumes of pitch pine and hemlock. Soft maple is the predominant hardwood, with lesser volumes of white and red oaks. Several unique vegetative-landform types occur on the Islands. The heathlands and moors of the western portion of Martha's Vineyard are interesting examples.

D. Climate

The average annual temperature is approximately 50 degrees Fahrenheit ($^{\circ}\text{F}$) with an average in January of about 30°F , and an average in July of about 71°F . Inland, the summers are hot and humid, but sea breezes cool the areas near the coast. The length of the growing season (frost free period above 32°F threshold) averages about 170 days. Growing season varies from less than 150 days inland to nearly 200 days in the immediate coastal areas.

Mean annual precipitation is about 44 inches. Snowfall depths vary widely from year to year, depending greatly on the track taken by winter storms.

Snowfall depths can easily range from 30 to 70 inches per year. Average snowfall in the Boston area is about 50 inches, with about 30 inches being the average for the southern part of the region including Cape Cod and the Islands. The average annual runoff is about 22 inches, over 50 percent of the average annual precipitation.

See Figures 5.3, 5.4, and 5.5 for Climatological Data.

E. Storms and Droughts

Major storms and subsequent floods have occurred in nearly every month of the year. Large storms which affect the region are usually fall hurricanes, summer thunderstorms, or winter "northeasters". The most significant storms were the hurricanes of September 1938, September 1944, August 1954, August 1955, and September 1960. In addition, major nonhurricane storms occurred in November 1944, November 1953, March 1963, and March 1968.

Droughts have occurred in the region, with the longest in recent memory extending from 1962 to 1967.

Stream gage data from USGS stations throughout the region is abstracted in Table 5.1.

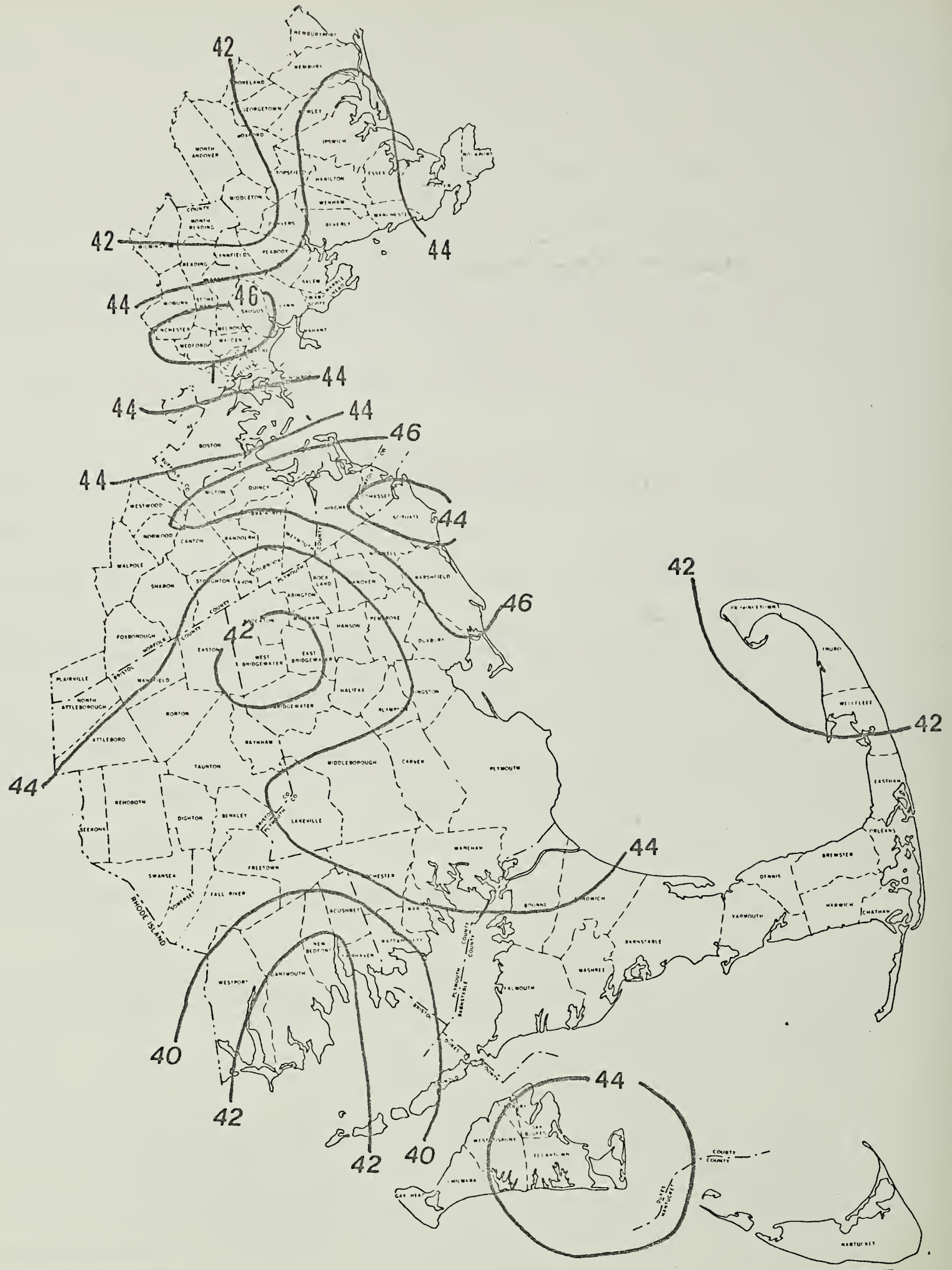


Fig 5.3
Average Annual Precipitation
(inches)

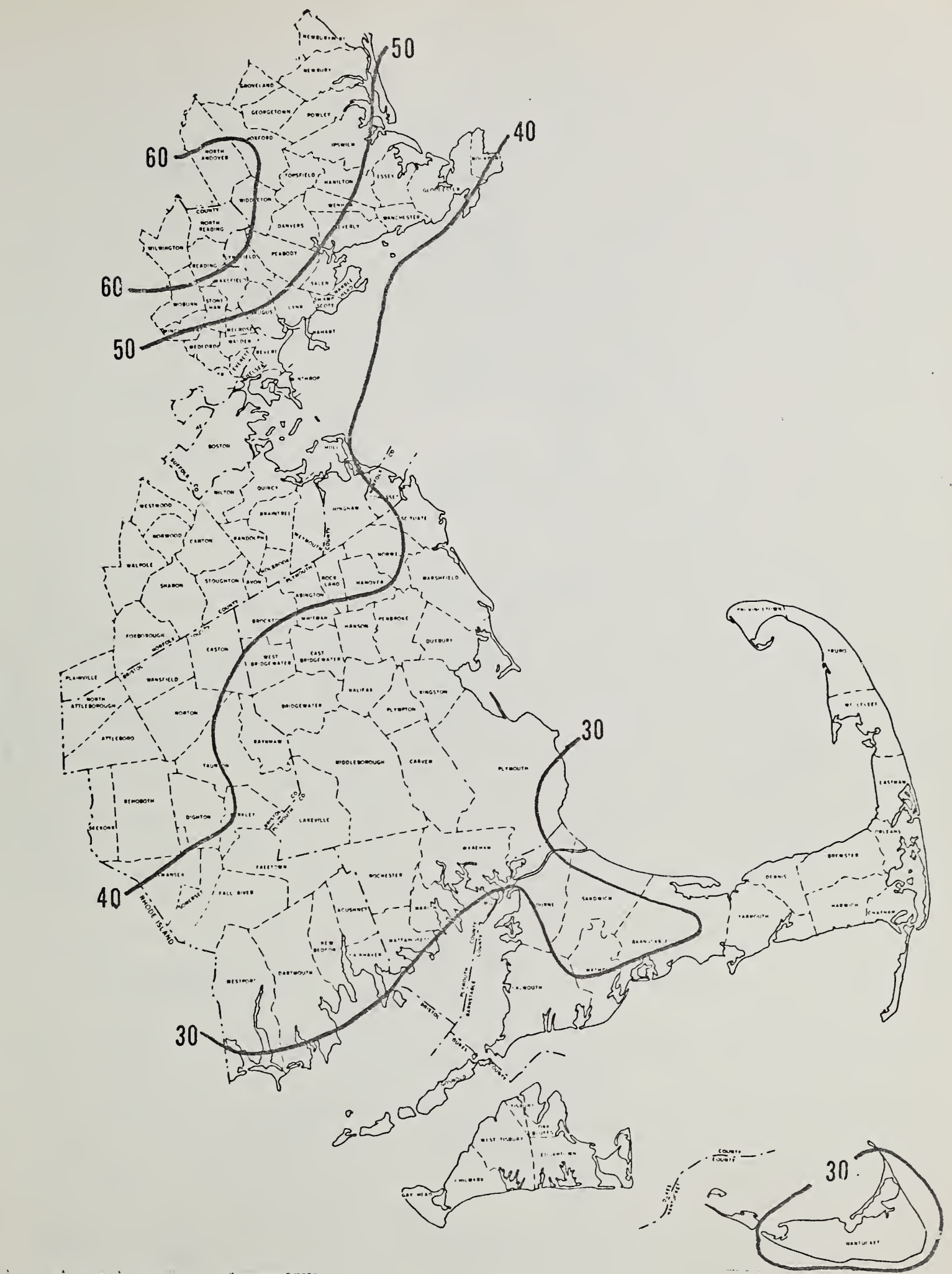


Fig 5.4
Average Annual Snowfall
(inches)

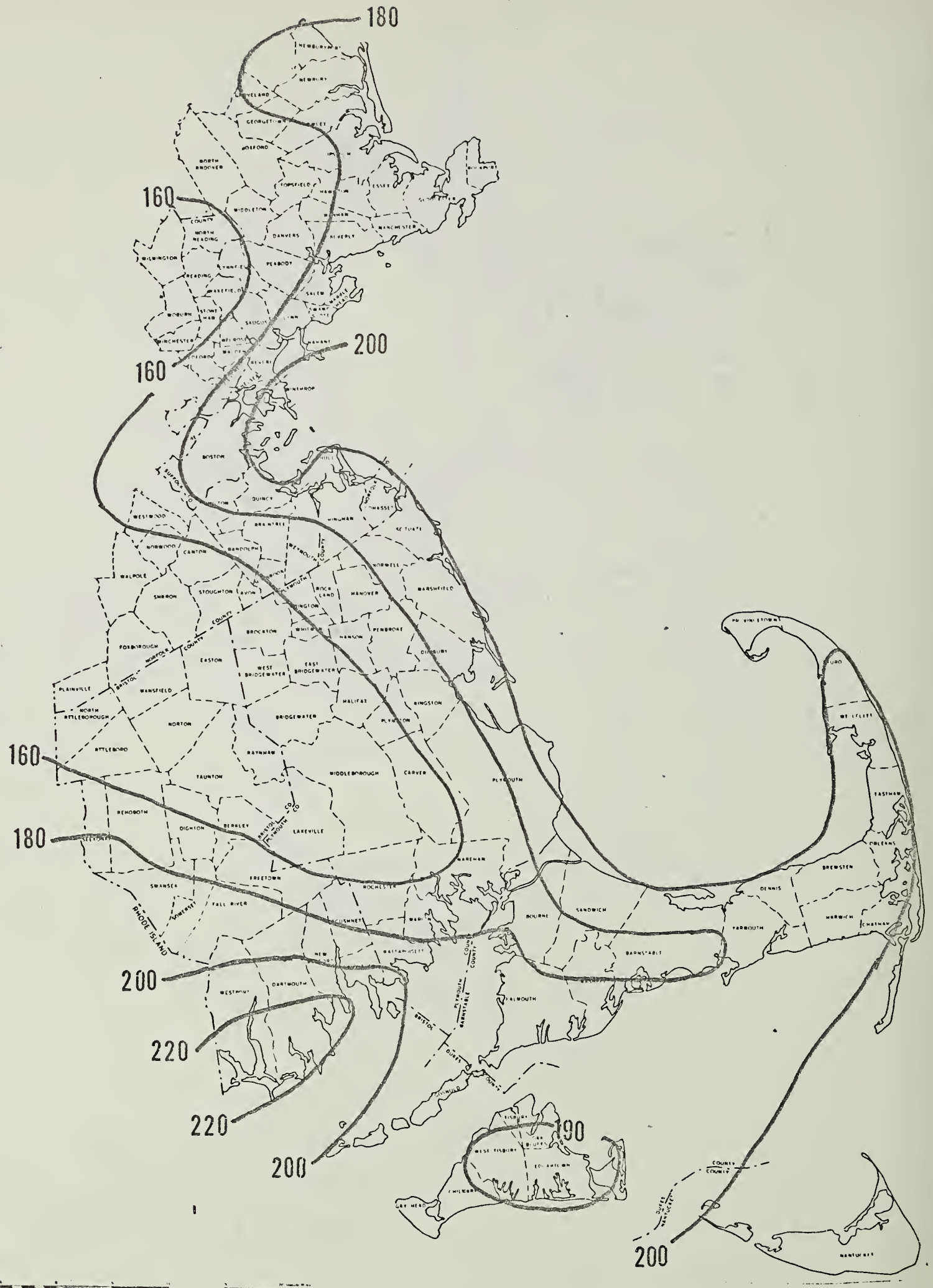


FIG 5.5
Average Annual Growing Season
(days)

TABLE 5.1 - STREAM GAGE DATA

USGS Stream Gage No.	Location	Drainage Area sq. mi.	Period of Record	Average Flow (cfs)	Minimum Flow (cfs)	Date	Maximum Flow cfs	Date
01101000	-Parker River Basin- Parker River @ Byfield	21.6	1945-present	35.7	.09	10/ 8/57	489	3/19/68
01101300	-Ipswich River Basin- Maple Brook @ Wilmington	3.99	10/62 - 9/74	7.32	0	Many	119	3/19/68
01101500	Ipswich River @ S. Middleton	43.4	6/38 - present	70.8	.003	10/ 1/57	833	3/19/68
01102000	Ipswich River near Ipswich	124	6/30 - present	201	.023	8/20/65	2680	3/20/68
01102500	-Mystic River Basin- Aberjona River @ Winchester	24.2	4/39 - present	27.4	.25	10/10/50	835	8/19/55
01105000	-Neponset River Basin- Neponset River @ Norwood	35.2	10/39 - present	52.6	1.4	10/20/63	1490	8/19/55
01105500	E. Branch Neponset @ Canton	27.2	10/52 - present	51.3	.6	9/ 1/57	1790	8/19/55
01105600	-Weymouth Back River Basin- Old Swamp River @ S. Weymouth	4.25	5/66 - present	9.81	.11	9/10/71	132	3/18/68
01105730	-North River Basin- Indian River @ Hanover	30.3	7/66 - present	63.7	.23	7/14/71	1390	3/18/68
01105870	-Jones River Basin- Jones River @ Kingston	15.8	8/66 - present	32.9	.59	8/11/66	575	3/19/68
01105880	-Herring River Basin- Herring River @ North Harwich	9.4	6/66 - present	11.0	.85	10/ 9/66	59	9/ 3/72
01107000	-Taunton River Basin- Dorchester Brook near Brockton	4.7	10/62 - 9/74	8.3	0	9/ 9/64	359	3/18/68
01108000	Taunton River near Bridgewater	260	10/29 - present	485	81/	9/10/44	4980	3/20/68
01108500	Wading River @ West Mansfield	19.2	10/53 - present	34.7	01/	10/24/57	541	3/19/68
01109000	Wading River near Norton	42.4	6/52 - present	72.7	.3	9/10/76	1460	3/19/68
01109060	Threemile River @ North Dighton	83.8	7/66 - present	169	5.3	8/27/74	2490	3/19/68
01109070	Segreganset River near Dighton	10.6	7/66 - present	22.3	0	8/30/74	867	3/18/68
01109200	-Palmer River Basin- West Branch Palmer River near Rehoboth	4.34	10/62 - 9/74	8.3	0	1974	441	3/18/68

1/ Caused by upstream storage.

5.2 LAND USE

A. Agricultural Land

Land use in the Coastal Region is dominated by forest and urban land uses which comprise nearly 75 percent of the total acreage. About 6 percent of the area is in agricultural use, while water, wetlands, and other land uses make up the balance.

In the 20-year period between 1951 and 1971, significant land use changes occurred. Agricultural land decreased by slightly more than 100,000 acres (47.6 percent). In 1951, 12.4 percent of the area was in agricultural use; by 1971, only 6.4 percent was in such use. On the other hand, urban land uses went from 200,191 acres in 1951 (11.9 percent of the area), to 345,253 acres in 1971 (20.6 percent of the area), an increase of 145,062 acres, representing a 72.5-percent gain. Of the three subregions, the Cape Cod-Islands area showed the most significant changes. Table 5.2 summarizes these changes. There are indications that the rate of decline in agricultural land may have decreased in some areas of the region during the 1970s. Dukes County appears to be a specific case where agricultural land may have actually increased in the 1969-1974 period.

TABLE 5.2 - LAND USE CHANGES, 1951 - 1971

Area	Agricultural Land		Urban Land		Forestland	
	% Change	(AC)	% Change	(AC)	% Change	(AC)
Northeast	-60.8	- 29,938	49.2	44,096	- 8.35	-15,830
Southeast	-40.8	- 53,369	79.7	71,231	- 9.50	-54,043
Cape Cod- Islands	-62.6	- 17,862	154.7	32,845	-11.40	-38,032
Region	-48.5	-101,169	72.5	145,062	- 9.70	-97,905

SOURCE: MacConnell, et al.

Table 5.3 summarizes the land resource base in the region and the shares of each land use category to the total land base by each subregion for the years 1951 and 1971. It is important to note that the "other" land use category is composed of the following subcategories, as presented by MacConnell, et al.:

1. Abandoned fields, most of which are reverting to forestland or scrub brush;
2. abandoned fruit orchards;
3. gas, telephone, oil, or power line rights-of-way 100 feet or more wide maintained through wooded areas;
4. mining and waste disposal areas;
5. open or undeveloped land which is in the midst of or adjacent to urban areas; and
6. lands used for recreational purposes.

In 1971, there were 139,875 acres within the other land use category. Over 47,000 of these acres were either in abandoned fields or orchards (In 1951, there were slightly more than 57,500 acres in abandoned fields or orchards). The decrease in forestland between 1951 and 1971 would no doubt have been greater, if it were not for the fact that much land classified as "other" in 1951 reverted to forestland by 1971.

It should be noted that, when looking at the changes that have occurred, caution should be used. For example, increases in water acreage were due in part to the installation of water impoundments, but more accurate

Table 5.3

LAND USE, 1950 AND 1970

	Cropland 1	Pasture 2	Agricul- tural Land 1 + 2		Forest 3	Wetland 4	Water 5	Ind/Com 6	Resid 7	Inst. 8	Urban 6+7+8	Other 9	Total 10
<u>Northeast</u>													
1950	20,883	28,324	49,207	189,560	34,652	14,368	14,752	68,803	6,059	6,059	89,614	24,208	401,609
1970	10,846	8,423	19,269	173,730	26,709	19,192	24,871	95,852	8,877	8,877	129,600	33,109	401,609
Change in Acres	-10,037	-19,901	-29,938	-15,830	-7,943	4,824	10,119	27,049	2,818	2,818	44,096	8,901	
1950 Share (%)	5.2	7.0	12.2	47.2	8.6	3.6	3.7	17.1	1.6	1.6	22.3	6.0	
1970 Share (%)	2.7	2.1	4.8	43.3	6.6	4.8	6.2	23.9	2.2	2.2	32.3	8.2	
% Change in Share	-2.5	-4.9	-7.4	-3.9	-2.0	1.2	2.5	6.8	.6	.6	10.0	2.2	
<u>Southeast</u>													
1950	57,965	72,743	130,708	571,544	40,448	30,818	8,672	76,386	4,288	4,288	89,346	28,770	891,634
1970	54,326	23,013	77,339	517,501	33,437	41,781	28,180	125,346	8,051	8,051	161,577	59,999	891,634
Change in Acres	-3,639	-49,730	-53,369	-54,043	7,011	10,963	19,508	48,960	3,763	3,763	71,231	31,229	
1950 Share (%)	6.5	8.7	14.7	64.1	4.5	3.5	1.0	8.6	0.5	0.5	10.0	3.2	
1970 Share (%)	6.1	2.6	8.7	58.0	3.8	4.7	2.2	14.1	0.9	0.9	18.0	6.7	
% Change in Share	-0.4	-6.1	-6.0	-6.1	0.7	1.2	1.2	5.5	-0.4	-0.4	8.0	-3.5	
<u>Cape Cod/Islands</u>													
1950	12,404	16,152	28,556	246,064	22,573	31,424	1,839	17,441	1,951	1,951	21,231	37,649	386,497
1970	7,645	3,049	10,694	217,032	23,054	34,874	6,865	44,311	2,900	2,900	54,076	46,767	386,497
Change in Acres	-4,759	-13,103	-17,862	-28,032	-481	3,450	5,026	26,870	949	949	32,845	-9,118	
1950 Share (%)	3.2	4.2	7.4	63.4	5.8	8.1	0.5	4.5	0.5	0.5	5.5	9.7	
1970 Share (%)	2.0	0.8	2.8	56.2	6.0	9.0	1.8	11.5	0.8	0.8	14.0	12.1	
% Change in Share	-1.2	-3.4	-4.6	-7.2	0.2	-0.9	-1.3	7.0	0.3	0.3	8.5	-2.4	
<u>Coastal Region</u>													
1950	91,252	117,219	208,471	1,006,168	97,673	76,610	25,263	162,630	12,298	12,298	200,191	90,627	1,679,740
1970	72,817	34,485	107,302	908,263	83,200	95,847	59,916	265,509	19,828	19,828	345,253	139,875	1,679,740
Change in Acres	-18,435	-82,734	-101,169	-97,905	-14,473	19,237	34,653	102,879	7,530	7,530	145,062	49,248	
1950 Share (%)	5.4	7.0	12.4	59.9	5.8	4.6	1.5	9.7	0.7	0.7	11.9	5.4	
1970 Share (%)	4.3	2.0	6.4	54.1	5.0	5.7	3.6	15.8	1.2	1.2	20.6	8.3	
% Change in Share	-1.1	-5.0	-6.0	-5.8	-0.8	1.1	1.2	6.1	0.5	0.5	8.7	2.9	

analysis of the 1971 aerial photos also explains some of the increase. Minimum size of plots categorized in 1951 was 10 acres; in 1971, the minimum size was decreased to 3 acres. Thus, certain rivers and streams that were categorized as something other than water in 1951 were categorized as water in 1971.

The wetland category also poses a problem in that in 1951, beaver ponds seasonally flooded flats and bogs were categorized as the dominant adjacent land use. In 1971, however, they were included within the wetland category. In both years of analysis, wooded swamps were included as forestland, since photo interpretation precluded doing otherwise. Thus, the wetland category should be considered as open wetlands. The changes as listed in Table 5.3 should not be taken as gospel, but simply suggest the trends that have occurred in the land base for the twenty-year period.

In terms of acreage changes, the most significant categories are agricultural land and urban land. As Table 5.2 shows, agricultural land decreased 101,169 acres, a drop of nearly 48 percent. When it is considered that Massachusetts now imports approximately 85 percent of its food, a continuation of this trend is a rather disturbing thought. Much of the former agricultural acreage has gone into urban uses. From an agricultural perspective, although the actual conversion acreage may not be that large, there are a number of important ramifications.

From an economic viewpoint, agricultural earnings, while amounting to over \$200 million, are quite insignificant relative to the total earnings in the state. Agricultural pursuits employ less than one percent of the labor force and contribute comparably to total personal income. It should be noted, however, when agricultural enterprises are considered within the goals and objectives of local or regional planning groups, the simple economic viewpoint is inadequate.

There are a number of factors which appear to aggravate the continuing decrease in agricultural land:

1. Zoning ordinances--towns in the region have zoned agricultural land to permit residential use and, in some cases, industrial and commercial use. Most zoning regulations incorporate an implicit assumption that farming is a residual or temporary use which will be replaced by nonagricultural uses, and zoning often is in direct opposition to the land use objective of agricultural land preservation.

Section 81 of Chapter 41, General Laws, stipulates that for any development which will be placed upon frontage along already existing public roads, subdivision review is not required. Although recently introduced legislation has a requirement that any development on more than two lots would require subdivision approval, the fact that there

is no minimum time frame incorporated into the act somewhat diminishes its potential impact. The result is a large degree of strip development which creates the most expensive pattern for public services. Such development patterns also maximize the potential encroachment on agricultural land. For example, as development continues, farmer field operations taking place behind the strip may be subject to nuisance ordinances forced on the operator by the new residents who wield more political power. The indirect and direct impacts of zoning regulations seem to be opposed to the professed intent of preserving agriculture.

2. Relative to competing agricultural areas, especially those in truck farm type crops, Massachusetts' climate provides a relatively short growing season. When that factor is amalgamated with the distribution of soil groups, size of holdings, and labor costs, a negative comparative advantage results. As Christensen pointed out, nearly three million acres were cleared and used for agriculture in 1860. Today most of this land is now growing trees. But even if this former cropland was brought back into production, the resulting food costs would be higher than they now are because of the expense of working the land and the relatively low yields:

"Plowing and tilling an acre of stony land has a much higher cost than plowing an acre of nonstony land and, when this extra cost is combined with lower yields, the resulting food produce has a high production cost per unit of yield."

3. A third factor that helps explain the loss of agricultural land is the fact that there are very few storage facilities in the state; thus, the advantages of bulk shipping from the food and feed crop exporting areas cannot be gained. As a result, the unit cost of transporting the necessary productive inputs are high and, consequently, the cost of raising livestock and crops are higher than in those areas which have adequate storage facilities.

For example, in 1945, poultry production was the most important source of farm income in Massachusetts (38.1 percent), as compared to 1974 when it amounted to about 13 percent of the value of agricultural production. This decline was brought about by the vast expansion of poultry enterprises in the DelMarVa Peninsula and areas farther south. The climatic difference is such that corn and soybeans, the major feed ingredients, grow prolifically in these southern areas. When there are inadequacies in cropland area, the presence of large storage facilities permit the bulk transportation of feed at minimal costs. As a result, the poultry areas of the south now produce chickens at a lower cost, while equalling or exceeding the quality of the Massachusetts poultry product.

4. A fourth reason which explains the loss of agricultural land is two-fold: higher transportation rates and the lack of a coordinated marketing system. As Platt et al. diagrammed, Franklin and Hampshire Counties are the major agricultural areas in the state.

Most of this area bordering the Connecticut River is in vegetable crop production. But the lack of consistent product quality tied with a sporadic supply schedule has prevented the development of a vegetable processing industry or a well coordinated fresh-market system. As a result, other regions like Florida and California, with their longer growing seasons, greater crop varieties, and modern processing plants, supply a great deal of the fresh and processed vegetable products used by Massachusetts consumers.

In discussing the resource base, it is necessary to incorporate existing and potential legislation, in order to determine how these laws will affect the future resource base.

As a step in curbing the loss of agricultural land, the Massachusetts General Court enacted Chapter 61A in 1973, an act providing for the assessment of agricultural or horticultural land at a value based upon its agricultural or horticultural uses. Although a rigorous assessment of the impact of this act has not been undertaken, the general consensus is that it has been of minimal effectiveness in curbing the loss of agricultural land. The primary explanation for this result is that there was defacto agricultural assessment prior to the passage of the act. As Barlowe and Alter stated:

"How far use-value assessment programs can go in protecting agricultural and open space land depends largely on the emphasis given to the current use-protection objective.

Landowners have a natural economic incentive for favoring taxing arrangements that provide them with benefits and still leave them with the option of developing or selling their lands. A protection policy, in contrast, calls for tight declassification procedures that discourage or prevent withdrawals once lands have been accepted for (agricultural assessment) classification.

"These two objectives are in conflict. Programs that emphasize the first objective provide little protection for existing land uses while those that emphasize the protection goal offer little incentive for owner participation. Considerable emphasis has been given to protectionist goals in several laws enacted in the past decade, but even the most restrictive of these involves elements of compromise between the two objectives.

"Recognition of these factors prompts the conclusion that, by itself, use-value assessment cannot provide more than a partial answer to the farmland and open space preservation problem. Its chief merit lies in the role it can play in buying time, particularly in semi-rural areas, for state and local governments to seek and enact supplemental programs to protect agricultural and open space lands."

Defacto agricultural assessment has precluded the agricultural assessment act from being an effective means, whereby agricultural and horticultural lands could be preserved. However, the situation has recently changed, since each city and town must assess property values at 100 percent of market value. Such an assessment would preclude defacto assessments; therefore, the potential effectiveness of the agricultural assessment act may increase substantially.

To further the potential of agricultural preservation, the General Court first enacted a development rights bill which enables cities and towns to purchase the development rights to agricultural land.

No state funding was approved for this program and, unless arrangements are made for cost sharing, the future effectiveness of the development rights program appeared to be minimal. In 1977, the legislature passed Chapter 780, The Agricultural Restriction Program, establishing a state-run pilot program to acquire development rights. The program depends on cooperation of local conservation commissions and can be used in conjunction with the earlier act authorizing local purchase of development rights.

The effectiveness of a development rights program is somewhat limited, as land is only one of many productive inputs. In a recent investigation trying to explain the loss of agricultural land, the variables having to do with increased population growth, increasing taxes, and increased urbanization were insignificant in explaining the loss. This strongly suggests that the agricultural demise results from low net income to the agricultural community. To the extent that the development rights program supplies additional capital to the farmers and, such capital is invested in cost reducing measures, the development rights program may have some impact.

B. Agricultural Land Study

The U.S. Department of Agriculture is concerned about any action that tends to impair the productive capacity of American agriculture. The continuing loss of farmland in the Coastal Region is such an action. Nationwide, the SCS has a Land Inventory and Monitoring Program to make and keep current an inventory of the prime farmland and unique farmland. Farmlands that are of statewide or local importance for producing crops are also identified. The nation needs to know the extent and location of the best land for producing food, feed, fiber, and forage.

The first phase of the farmland inventory is being conducted in those counties which have published soil surveys available. In the Coastal Region, Plymouth County meets this criteria.

Three categories of farmland are being inventoried:

1. Prime Farmland--Prime farmland is land best suited for producing food, feed, forage, and fiber; and also available for these uses (the land could be cropland, pastureland, rangeland, forestland, or other land, but not urban, builtup land, or water). It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops economically when treated and managed, including water management, according to modern farming methods.
2. Unique Farmland--Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality and/or high yields of a specific crop when treated and managed according to modern farming methods. Examples of such crops in Massachusetts are cranberries and orchard fruit and grapes now in production on Martha's Vineyard.

Unique farmland has the following characteristics:

- a. It is used for a specific high-value food or fiber crop;
- b. it has a moisture supply that is adequate for the specific crop; the supply is from stored moisture, precipitation, or a developed irrigation system;
- c. it combines favorable factors of soil quality, growing season, temperature, humidity, air drainage, elevation, aspect, or other conditions, such as nearness to market, that favor the growth of a specific food or fiber crop.

3. Additional Farmland of Statewide and Local Importance--This is land, in addition to prime and unique farmlands, that is of statewide and local importance for the production of food, feed, fiber, and forage crops. Criteria for defining and delineating this land are to be determined by state and local personnel familiar with the specific needs of the region. These lands include some of those commonly utilized for pasture and hay.

Results of the Land Inventory and Monitoring Program for farmland in Plymouth County is expected to be available in early 1978.

To illustrate the dramatic irreversible loss of farmland in the Coastal Region, the Massachusetts Water Resources Study has analyzed data for 21 towns. Basic data was prepared in a manner which can make it useful to a variety of state and local agencies in efforts to protect existing farmland.

Towns were selected to represent a geographic distribution in the region. A prerequisite for inclusion of a town was the availability of a published soil survey for the community. Communities selected are shown on Figure 5.6.

Plymouth County towns were omitted from this study to avoid duplicating much of the results to be derived from the Land Inventory and Monitoring Program. The urban core surrounding Boston was also omitted because of the intense urbanization of that area.

A base map for the community was prepared at scale 1:24,000 (1 inch = 2,000 feet), using the U.S. Geological Survey topographic maps. Detailed soils data was adjusted to the base map and a transparent mylar overlay of the detailed soils map prepared. Another mylar overlay was constructed which indicated all prime farmland and farmland of state and local importance.

Using a transparent copy of this farmland soils overlay, land use data was added, using the 1971 Massachusetts Map Down maps. Existing farming was mapped wherever it occurred in the town. In addition, land uses were mapped for all areas of farmland soil.

The data contained in this combined farmland soils-land use overlay was measured and summarized. Results are presented in Table 5.4. Some interesting conclusions can be drawn from this study of farmland in the region.

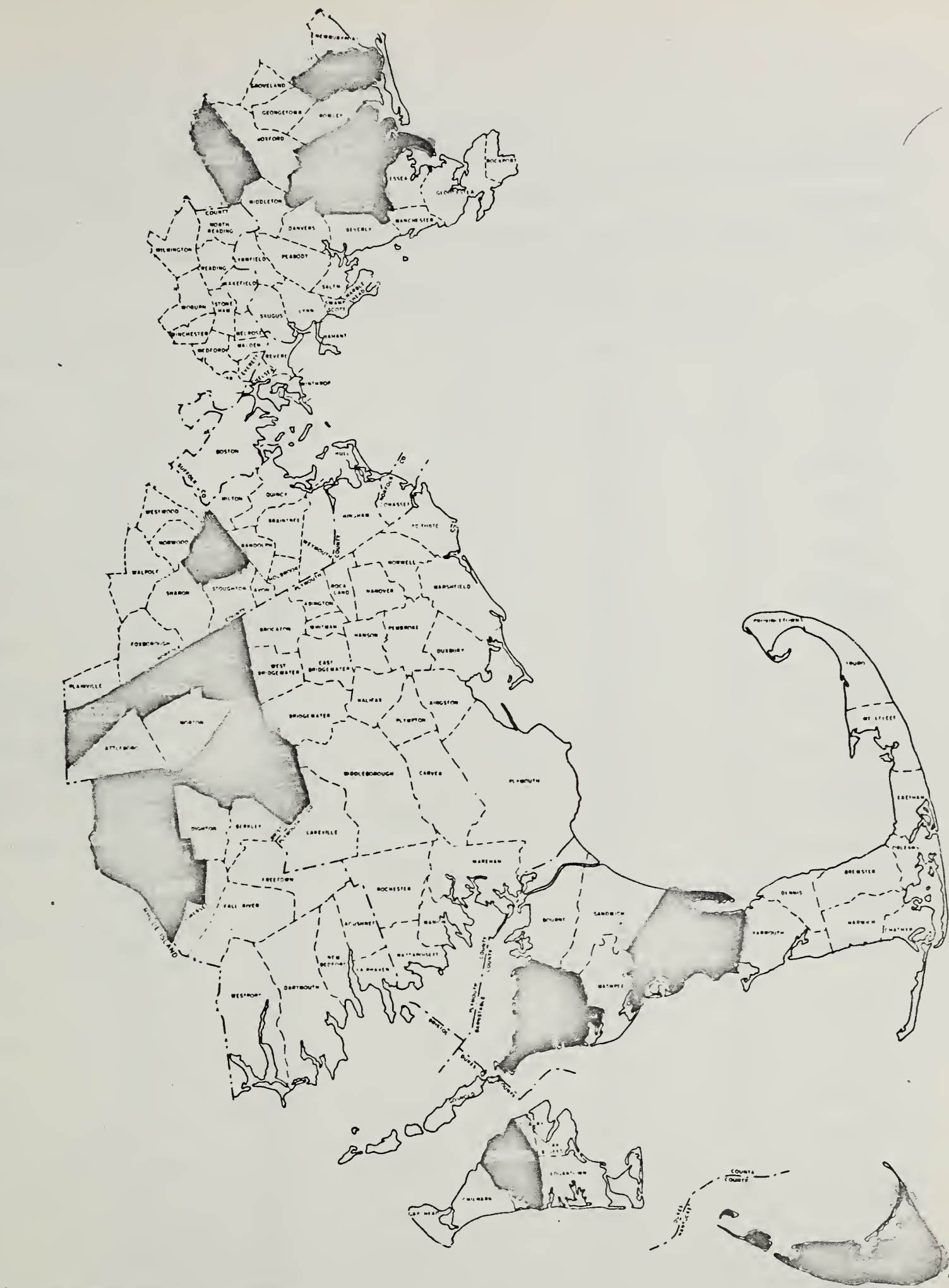


Figure 5.6
Communities Studied in
Agricultural Land Study

TABLE 5.4

EXISTING FARMLAND

Community	Cropland	Pasture	Orchard	Cranberry Bog	Total
Acres (Percent of Town Area)					
Barnstable	534 (1.6)	553 (1.6)	3 -	447 (1.3)	1537 (4.5)
Canton	310 (2.6)	112 (1)	0	0	422 (3.5)
Dartmouth	2650 (7.3)	2487 (6.9)	41 (0.1)	54 (0.1)	5232 (14.4)
Easton	337 (1.8)	919 (5)	3 -	75 (0.4)	1334 (7.3)
Falmouth	669 (2.4)	306 (1.1)	0	296 (1.1)	1271 (4.6)
Hamilton	300 (3.2)	834 (9)	11 (0.1)	0	1145 (12.3)
Ipswich	741 (4.4)	1485 (8.9)	78 (0.5)	0	2304 (13.7)
Mansfield	720 (5.6)	89 (0.7)	3 -	0	812 (6.3)
Nantucket	409 (1.4)	434 (1.5)	0	342 (1.2)	1185 (4)
Newbury	1160 (10.8)	728 (6.8)	11 (0.1)	0	1899 (17.8)
North Andover	859 (5)	877 (5.1)	93 (0.5)	0	1829 (10.7)
North Attleborough	1462 (11.9)	187 (1.5)	0	0	1649 (13.4)
Raynham	533 (4.1)	865 (6.7)	6 -	25 (0.2)	1429 (11)
Rehoboth	3527 (11.7)	931 (3.1)	19 (0.1)	0	4477 (14.8)
Seekonk	1749 (14.6)	327 (2.7)	8 (0.1)	0	2084 (17.3)
Swansea	1885 (13.4)	337 (2.4)	65 (0.5)	0	2287 (16.3)
Taunton	1276 (4.4)	1316 (4.6)	3 -	88 (0.3)	2683 (9.3)
Topsfield	486 (6)	397 (4.9)	15 (0.2)	0	898 (11.1)
Wenham	223 (4.4)	329 (6.5)	15 (0.3)	0	567 (11.2)
Westport	4655 (14.8)	636 (2)	22 (0.1)	0	5313 (16.9)
West Tisbury	664 (4.1)	166 (1)	0	0	830 (5.2)

TABLE 5.5

PRIME FARMLAND SOILS

Community	Land Use						Total*
	Cropland	Pasture	Orchard	Forest	Available	Urban	
	Acres (Percent of Prime Soils in this Land Use)						
Barnstable	78 (2.1)	134 (3.7)	0	2638 (72.1)	186 (5.1)	662 (17.0)	3658 (10.6)
Canton	192 (14.0)	15 (1.1)	0	396 (28.7)	86 (6.2)	689 (50.0)	1378 (11.4)
Dartmouth	1494 (24.4)	1319 (21.5)	22 (0.4)	1194 (19.5)	285 (4.7)	1810 (29.6)	6124 (16.9)
Easton	124 (5.4)	266 (11.5)	0	1128 (48.8)	184 (8.0)	608 (26.3)	2310 (12.7)
Falmouth	511 (10.3)	152 (3.1)	0	2921 (58.9)	576 (11.6)	800 (16.1)	4960 (17.9)
Hamilton	183 (6.8)	449 (16.7)	11 (0.4)	1100 (41.0)	69 (2.6)	870 (32.4)	2682 (28.9)
Ipswich	386 (9.6)	752 (18.7)	73 (1.8)	1511 (37.6)	424 (10.6)	868 (21.6)	4014 (23.9)
Mansfield	204 (12.6)	37 (2.3)	3 (0.2)	681 (42.1)	101 (6.2)	592 (36.6)	1618 (12.6)
Nantucket	137 (3.4)	55 (1.4)	0	1133 (28.4)	1836 (46.1)	823 (20.7)	3984 (13.4)
Newbury	561 (36.4)	243 (15.8)	8 (0.5)	463 (30.1)	95 (6.2)	169 (11.0)	1539 (14.4)
N. Andover	347 (13.1)	286 (10.8)	18 (0.7)	576 (21.8)	160 (6.0)	1261 (47.6)	2648 (15.5)
North Attleborough	541 (44.7)	8 (0.7)	0	363 (30.0)	47 (3.9)	250 (20.7)	1209 (9.8)
Raynham	108 (12.0)	100 (11.1)	0	486 (54.1)	48 (5.3)	156 (17.4)	898 (6.9)
Rehoboth	1132 (33.1)	139 (4.1)	9 (0.3)	1563 (45.7)	173 (5.1)	407 (11.9)	3423 (11.3)
Seekonk	536 (39.8)	46 (3.4)	0	227 (16.7)	76 (5.6)	461 (34.2)	1346 (11.2)
Swansea	539 (29.2)	38 (2.1)	24 (1.3)	256 (13.9)	72 (3.9)	915 (49.6)	1844 (13.1)
Taunton	180 (12.5)	337 (23.4)	3 (0.2)	613 (42.6)	117 (8.1)	189 (13.1)	1439 (5)
Topsfield	249 (14.7)	194 (11.4)	10 (0.6)	688 (40.6)	125 (7.4)	429 (25.3)	1695 (20.9)
Wenham	138 (13.9)	163 (16.4)	3 (0.3)	331 (33.3)	32 (3.2)	326 (32.8)	993 (19.6)
Westport	2408 (63.0)	85 (2.2)	0	464 (12.1)	126 (3.3)	741 (19.4)	3824 (12.2)
West Tisbury	428 (6.9)	72 (1.2)	0	5117 (82.1)	474 (7.6)	142 (2.3)	6233 (39.0)

*Percent of the town in Prime Farmland Soil.

TABLE 5.6

SOILS OF STATE AND LOCAL IMPORTANCE FOR FARMING

Community	Land Use						Total*
	Cropland	Pasture	Orchard	Forest	Available	Urban	
	Acres (Percent of State and Local Important Soils in this Use)						
Barnstable	240 (3.2)	168 (2.2)	0	5040 (67.3)	491 (6.6)	1529 (20.5)	7468 (21.7)
Canton	51 (2.4)	34 (1.6)	0	987 (47.4)	109 (5.2)	901 (43.3)	2082 (17.3)
Dartmouth	394 (5.8)	364 (5.3)	2 (0)	4238 (62.1)	398 (5.8)	1427 (20.9)	6823 (18.8)
Easton	75 (1.8)	197 (4.8)	0	2627 (63.7)	192 (4.7)	1030 (25.0)	4121 (22.6)
Falmouth	111 (2.5)	93 (2.1)	0	2533 (56.2)	334 (7.4)	1437 (31.9)	4508 (16.2)
Hamilton	64 (3.1)	225 (10.8)	0	1306 (62.7)	45 (2.2)	444 (21.3)	2084 (22.5)
Ipswich	241 (6.2)	257 (6.7)	3 (0.1)	2305 (59.8)	234 (6.1)	814 (21.1)	3854 (23.0)
Mansfield	98 (5.1)	8 (0.4)	0	1447 (76.0)	39 (2.0)	312 (16.4)	1904 (14.8)
Nantucket	2 (0.2)	8 (1.0)	0	592 (71.1)	178 (21.4)	53 (6.4)	833 (2.8)
Newbury	223 (24.0)	71 (7.6)	0	296 (31.9)	91 (9.8)	247 (26.6)	928 (8.7)
N. Andover	248 (6.6)	233 (6.2)	45 (1.2)	2305 (61.6)	148 (4.0)	763 (20.4)	3742 (21.9)
North Attleborough	287 (9.8)	47 (1.6)	0	1871 (63.8)	124 (4.2)	604 (20.6)	2933 (23.9)
Raynham	172 (4.0)	389 (9.0)	5 (0.1)	2717 (63.0)	207 (4.8)	826 (19.1)	4316 (33.3)
Rehoboth	1146 (24.2)	209 (4.4)	5 (0.1)	2459 (51.9)	279 (5.9)	635 (13.4)	4728 (15.6)
Seekonk	595 (20.8)	124 (4.3)	7 (0.2)	1131 (39.5)	225 (7.9)	781 (27.2)	2863 (23.8)
Swansea	619 (17.8)	98 (2.8)	38 (1.1)	1636 (47.0)	282 (8.1)	805 (23.1)	3478 (24.8)
Taunton	636 (6.7)	489 (5.2)	0	5519 (58.6)	600 (6.4)	2182 (23.1)	9426 (32.6)
Topsfield	142 (5.2)	117 (4.3)	2 (0.1)	1617 (59.5)	126 (4.6)	712 (26.2)	2716 (33.5)
Wenham	57 (5.5)	101 (9.7)	3 (0.3)	443 (42.4)	29 (2.8)	411 (39.4)	1044 (20.6)
Westport	1260 (14.4)	22 (0.3)	11 (0.1)	5720 (65.2)	459 (5.2)	1297 (14.8)	8769 (27.9)
West Tisbury	80 (3.2)	55 (2.2)	0	2191 (88.5)	100 (4.0)	51 (2.1)	2477 (15.5)

*Percent of Town in Soils of State and Local Importance for Farming.

TABLE 5.7 PRIME FARMLAND SOILS AND SOILS OF STATE AND LOCAL IMPORTANCE FOR FARMING

Community	Land Use						Total
	Cropland	Pasture	Orchard	Forest	Available	Urban	
	Acres (Percent of Prime Farmland Soils and Soils of State and Local Importance in this Land Use)						
Barnstable	318 (2.9)	302 (2.7)	0	7678 (69.0)	677 (6.1)	2151 (19.3)	11,126 (32.3)
Canton	243 (7.0)	49 (1.4)	0	1383 (40.0)	195 (5.6)	1590 (46.0)	3,460 (28.7)
Dartmouth	1888 (14.6)	1683 (13.0)	24 (0.2)	5432 (42.0)	683 (5.3)	3237 (25.0)	12,947 (35.7)
Easton	199 (3.1)	463 (7.2)	0	3755 (58.4)	376 (5.8)	1638 (25.5)	6,431 (35.3)
Falmouth	622 (6.6)	245 (2.6)	0	5454 (57.6)	910 (9.6)	2237 (23.6)	9,468 (34.1)
Hamilton	247 (5.2)	674 (14.1)	11 (0.2)	2406 (50.5)	114 (2.4)	1314 (27.6)	4,766 (51.5)
Ipswich	627 (8.0)	1009 (12.8)	76 (1.0)	3816 (48.5)	658 (8.4)	1682 (21.4)	7,868 (46.9)
Mansfield	302 (8.6)	45 (1.3)	3 (0.1)	2128 (60.4)	140 (4.0)	904 (25.7)	3,522 (27.5)
Nantucket	139 (2.9)	63 (1.3)	0	1725 (35.8)	2014 (41.8)	876 (18.2)	4,817 (16.3)
Newbury	784 (31.8)	314 (12.7)	8 (0.3)	759 (30.8)	186 (7.5)	416 (16.9)	2,467 (23.1)
N. Andover	595 (9.3)	519 (8.1)	63 (1.0)	2881 (45.1)	308 (4.8)	2024 (31.7)	6,390 (37.4)
North Attleborough	828 (20.0)	55 (1.3)	0	2234 (53.9)	171 (4.1)	854 (20.6)	4,142 (33.7)
Raynham	280 (5.4)	489 (9.4)	5 (0.1)	3203 (61.4)	255 (4.9)	982 (18.8)	5,214 (40.3)
Rehoboth	2278 (27.9)	348 (4.3)	14 (0.2)	4017 (49.3)	452 (5.5)	1042 (12.8)	8,151 (26.9)
Seekonk	1131 (26.9)	170 (4.0)	7 (0.2)	1358 (32.3)	301 (7.2)	1242 (29.5)	4,209 (35.0)
Swansea	1158 (21.8)	136 (2.6)	62 (1.2)	1892 (35.6)	354 (6.7)	1720 (32.3)	5,322 (37.9)
Taunton	816 (7.5)	826 (7.6)	3 (0.03)	6132 (56.4)	717 (6.6)	2371 (21.8)	10,865 (37.6)
Topsfield	391 (8.9)	311 (7.1)	12 (0.3)	2305 (52.3)	251 (5.7)	1141 (25.9)	4,411 (54.4)
Wenham	195 (9.6)	264 (13.0)	6 (0.3)	774 (38.0)	61 (3.0)	737 (36.2)	2,037 (40.1)
Westport	3668 (29.1)	107 (0.8)	11 (0.09)	6184 (49.1)	585 (4.6)	2038 (16.2)	12,593 (40.1)
West Tisbury	508 (5.8)	127 (1.5)	0	7308 (83.9)	574 (6.6)	193 (2.2)	8,710 (54.4)

TABLE 5.8

"OTHER"^{1/} SOILS BEING FARMED

Community	Acres				Total	Percent of Existing Farmland Located on "Other Soils" ^{2/}
	Cropland	Pasture	Orchard	Cranberry Bogs		
Barnstable	216	251	3	430	900	43.1
Canton	67	63	0	0	130	30.8
Dartmouth	762	805	17	54	1638	30.6
Easton	138	456	3	75	672	47.4
Falmouth	47	63	0	296	406	11.3
Hamilton	53	160	0	0	213	18.6
Ipswich	114	476	2	0	592	25.7
Mansfield	418	44	0	0	462	56.9
Nantucket	270	371	0	342	983	76.0
Newbury	376	413	3	0	792	41.7
North Andover	264	358	30	0	652	35.6
No. Attleborough	634	132	0	0	766	46.4
Raynham	253	376	1	25	655	44.9
Rehoboth	1249	583	5	0	1837	41.0
Seekonk	618	157	1	0	776	37.2
Swansea	727	202	3	0	932	40.7
Taunton	460	490	0	88	1038	36.6
Topsfield	95	86	2	0	183	20.4
Wenham	28	65	8	0	101	17.8
Westport	987	331	11	0	1329	25.0
West Tisbury	156	39	0	0	195	23.5

^{1/}"Other" soils are all soils except those classified as prime farmland soils or soils of state and local importance for farming.

^{2/}Percentage excludes cranberry bogs which are unique farmlands.

First, agricultural land use represents a very small percentage of total town area. Agricultural use ranges from 17 percent of the area of Seekonk to only 4 percent for Barnstable, Falmouth, and Nantucket.

Prime farmland soils constitute less than 20 percent of most towns sampled.

In many of the towns, a small percentage of the prime farmland soils is being used for agriculture. In fact, for nearly half of the towns, the area in urban land use exceeded that in agriculture.

In over half of the towns, forestland represents the greatest land use on prime farmland soils.

For soils of state and local importance, many of the same conclusions are evident:

1. These soils constitute about 25 percent of the town area;
2. a small percentage of the land is being used for agriculture with a greater percentage used for urban land;
3. forestland represents the greatest land use.

A surprising percentage of the existing farmland is located on soils other than prime farmland or soils of state and local importance.

It is logical to suppose that urban development has taken place on prime farmland because many of the factors which make farmland prime also make prime building land. Gentle slopes, lack of rocks, good drainage, freedom from flooding all favor development as well as farming.

The implications for potential erosion problems on the large percentage of farmland located on "other" soils cannot be ignored. These soils usually require good conservation practices to avoid excessive erosion losses. Naturally, these conservation practices add to the "cost of doing business" for the farmer.

John Foster of the Department of Food and Resource Economics, University of Massachusetts, undertook a study similar to that which has been described above. In Foster's study, a sample of 26 towns was examined to determine the changes that occurred on agricultural land between 1951 and 1971. His findings are very similar to those enumerated above: 42 percent of the better agriculture soils are in forestland because of previous reversion, and urban land is found on 12 percent of these soils. His sample of 26 towns differed somewhat in that he chose only those towns with large agricultural areas relative to urban areas. As a result, his findings showed that in 1971, intensive agriculture (tilled land, orchard and nursery uses) was found on 25 percent or 119,000 acres of the better agricultural soils in the state.

Foster also developed a data base to show how agricultural land uses changed in the state between 1951 and 1971. He delineated the 1971 acres of tilled land among three soil productivity groups: "best", "good", and "poor". Approximately half of the state's tilled land was found on soils classified as "best" for agriculture, and another third was found on moderately good soils. Between 1951 and 1971, 5,900 acres per year were lost from tilled agricultural land to nonagricultural uses. Of this amount, 1,700 acres were classified as "best" agricultural land and went into the following uses: 400 became abandoned, 900 moved into urban uses, 200 became forested, and another 200 went into other uses (primarily recreation, but also includes mining, waste disposal, and wetlands). Another 1,500 acres were classified as "good" agricultural soil and went into the following uses: 400 became abandoned, 700 went to urban uses, 200 went to forest uses, and another 200 went to other uses. A total of 56,000 acres went from tilled agricultural land of all types to urban uses between 1951 and 1971, and 32,000 acres of that amount were "best" and "good"

agricultural land. In summary, almost half of the agricultural land that went into nonagricultural uses was relatively good productive agricultural land. It must also be recognized that there were 84,000 acres of best and moderate agricultural land that were abandoned between 1951 and 1971. This acreage, unless committed to another use, will also revert to forestland.

To assist communities in assessing the status of their agricultural resource base, the Soil Conservation Service can provide a limited number of transparent overlays of the data compiled for this agricultural land study. The map data can be helpful in visualizing the extent of agricultural soils, existing agricultural enterprise, and in predicting future agricultural impacts of urban growth. The maps should be useful to planning boards, zoning boards of appeal, and conservation commissions. They are especially useful to communities about to embark on measures designed to protect their agricultural resources.

To illustrate the types of data available and the scope of information contained therein, a map has been prepared for the town of North Attleborough and printed as Figure 5.7 of this report. This map is the combination of three overlays and is intended to publicize the data available in the 20-communities which were sampled. Several other combinations or permutations of the basic overlays are possible, depending on the needs of the community. Interested town officials should direct their requests to the County Conservation District.

C. Forest Land

Forest land provides economic, environmental, and social benefits. These benefits are in the form of wood products, water, wildlife, forage, and

Figure 5.7

MAP of North Attleboro

Multi-color Foldout map
depicting

- 1 Base (black)
- 2 Prime Agricultural Land (yellow)
- 3 Land of State and Local Importance (green)
- 4 Land use on 2 & 3
- 5 All existing agricultural land

recreation. The types and amounts of benefits produced from forest land are determined by the owners, subject to factors such as forest location, land productivity, and land conditions of site and soil. The owner of forest land can, for example, use his land for wood products, forage, and recreation, and, within limitations, determine the mix of these benefits. Forest landowners can also manage their properties to enhance water and wildlife benefits, even though these benefits transcend ownership boundaries.

The ownership of forest land, the number of acres owned, and the reasons for owning forest land provide data useful to make inferences on the forest land resource base and on the potential output of benefits from forest land.

Approximately 908,000 acres are classed as forest land. Approximately 86 percent of the forest land is in private ownership, including individuals, partnerships, and corporations. Privately-owned lands are usually not open to the general public. Fourteen percent of the forest land is in public ownership. Publicly-owned lands are usually open for public use, with certain exceptions.

Most commercial forest land in the Coastal Region is in small tracts. An estimated 70 percent of the owners own 9 or fewer acres. These owners own 18 percent of the total acres. Ninety-four percent of the owners own 49 or fewer acres. These owners own 53 percent of the total acres (Table 5.9).

TABLE 5.9 - PRIVATE OWNERS OF COMMERCIAL FOREST
LAND AND ACRES OWNED^{1/}

SIZE CLASS (Acres)	NUMBER OF OWNERS (Percent)	ACRES OWNED (Percent)
1- 9	70	18
10- 19	11	10
20- 49	13	25
50- 99	4	17
100-199	1	11
200-499	1	10
500+	less than 0.5	9

^{1/} Derived from unpublished data on forest land ownership in Massachusetts, Northeastern Forest Experiment Station, Upper Darby, Pennsylvania.

Most commercial forest landowners in Massachusetts do not own land for strictly forest product production purposes. A study by Kingsley of commercial forest landowners in Massachusetts shows that 73 percent of the owners own forest land for land investment, recreation, or view land as part of their residence. These groups own 66 percent of the commercial forest land (Table 5.10).

TABLE 5.10 - REASONS FOR OWNING FOREST LAND

REASON	PERCENT OF OWNERS	PERCENT OF ACREAGE
Land investment	16	19
Recreation	16	21
Timber production	4	10
General farm use	9	12
Part of the residence	41	26
Other	14	12
TOTAL	100	100

Kingsley estimated that 56 percent of the privately-owned commercial forest land in Southern New England (Massachusetts, Connecticut, and Rhode Island) is available for the cutting of wood products.

Based on this percentage, 508,000 acres of forest land in the Coastal Region are available for the cutting of wood products. The acreage available does not take into account such necessary factors as timber quality, site conditions, logging conditions, or the economics of logging.

5.3 INLAND FLOODING

The Massachusetts Water Resources Study has focused its emphasis in the area of flooding on inland flooding only. Although damage from tidal flooding in the region is severe, there are no viable options available through USDA programs to reduce the damage. In fact, in most of the region, there are no alternatives to reduce tidal damage except the relocation of flood prone development. The National Flood Insurance Program, with its restriction on development of flood prone areas, will do much to limit future increases in coastal flood damage, but the existing damageable property will remain at peril.

The Massachusetts Office of Coastal Zone Management is involved in the development of data to assess tidal flooding hazards and to develop policies for limiting property damage from such events. Programs of the New England Division of the Army Corps of Engineers have been utilized to reduce major urban tidal flooding in the region. The Charles River Dam in Boston and the New Bedford Hurricane Barrier are perhaps the best known of the Corps' projects.

Major inland floods in the region have been the result of hurricane rains dumping great volumes of water over a two- or three-day period, or late winter storms causing rain to fall on frozen ground, or snow, resulting in relatively large runoff volume. The most recent hurricane which caused large scale inland flooding was hurricane Diane in August of 1955. Rainfall from the storm exceeded 15 inches, with nearly 12 inches concentrated in one 24-hour period. In the Neponset and Mystic River Basins, the Diane hurricane flood remains the largest recorded flow. For the other basins in the region, however, the storm of March 17-19, 1968 produced the record flood discharges. According to the U.S. Geological Survey "The Flood of March 18-20 was outstanding. Many streams with long-term streamflow records experienced flood peaks that exceeded previous maximums. For the Ipswich River, the March maximum flow was the greatest since at least 1886, the year of another great winter flood. At Charles River Village on the Charles River, the peaks equaled that of August 1955, both of which were greater than any other since at least 1886. Many streams reached peaks with recurrence intervals greater than 50 years. Streams such as the Wading and Taunton Rivers in southeastern Massachusetts had peak flows of this magnitude."

The March 1968 storm produced from two to seven inches of rainfall in the region (See Figure 5.8).

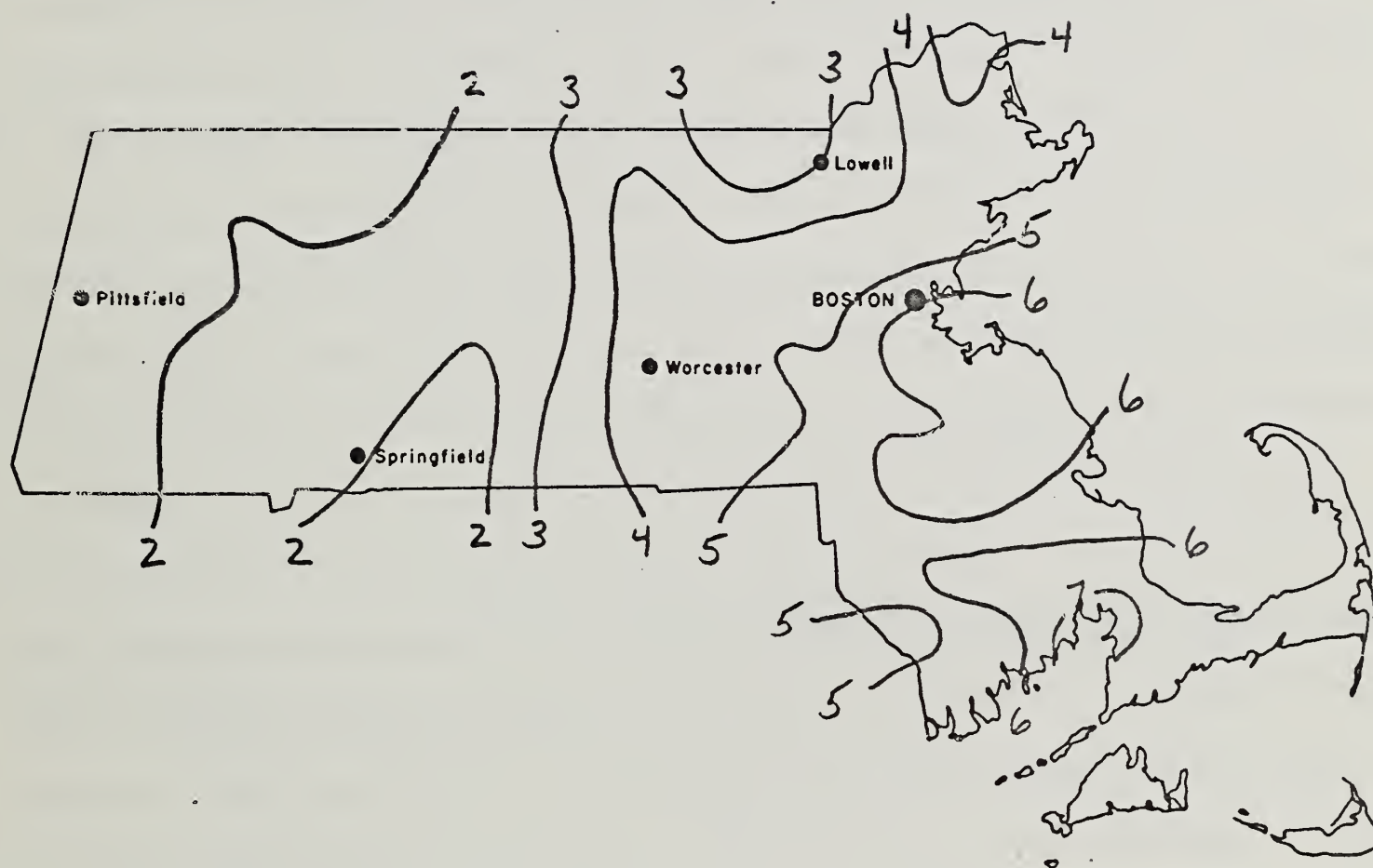


FIGURE 5.8

Precipitation (in inches) for the storm of March 17-19, 1968.

A large part of the snow cover in the region had melted prior to the storm of March 17-19. Wetlands were already saturated and streamflows were above normal. When the rains fell on frozen ground, the resulting floods were inevitable.

The flood of March 1968 caused damage to a number of properties which had been developed in the late 1950s and early 1960s. Many of the property owners did not consider themselves to be in a flood prone area. The "1968 Post Flood Report for Flood of 18-25, March 1968 in New England" summed the problem as follows: "Many of the developments are some distance from major streams and the threat of flooding was not apparent. Moreover, the first half of the 1960 decade was a time of drought in the northeast, and this tended to mask the problem as ground water levels were at record lows during the period. With the return to normal levels in 1967, the area needed only a major storm with rapid runoff to be in real trouble."

As urbanization and suburbanization extended outward from the Boston Metropolitan area, pressure to fill in and develop wetland areas proceeded at a rapid pace. The development of wetlands was especially rampant in Norfolk County and decreased as the distance from Boston increased. From 1951 to 1971, the Massachusetts Map Down figures indicate that the shallow freshwater wetland area in Norfolk County decreased from 10,200 acres to only 5,800 acres. Although the loss was not as severe in other counties of the region, the same pattern of filling is apparent.

The filling of wetlands for development not only endangered the developed area itself, but compounded problems downstream. As a wetland was filled, its ability to reduce flood peaks by storing water for later release was diminished. In addition, the conversion of marshland and vegetation to rooftops and paved parking lots resulted in an increased volume of runoff for an equal amount of rainfall.

Historically, many industries were located on the flood plain, because water was used for power. The alternative of developing in the uplands was more costly, since it meant substituting a more expensive energy source, if water was needed for power, or transporting plant wastes a greater distance, if water was needed as a discharge medium. Roads were developed on flood plains because of lower installation costs--it was less expensive to build on the flat valley lands than to route highways over upland terrain. Residential building was the result of lower site development costs associated with flood plain lands. In addition, much residential development was stimulated by the existing industrial flood plain development; i.e., housing for factory workers was often located on the same flood plain as the factory, for convenience.

In flood plain development, one significant cost determinant was often excluded from the decision-making process--this being the cost of flood damage. In some instances, the flood hazard was not recognized or not present in the same severity at the time of construction. In other cases, the hazard was recognized, but the severity was misjudged. In still other cases, federal disaster assistance after the flood encouraged rehabilitation of flood damaged property in the same location.

Field investigations made by the Soil Conservation Service indicate that average annual, inland flood damage in the region exceeds \$2,400,000, and that a 100-year frequency flood would cause damage in excess of \$21 million. Average annual damages and damage expected from a 100-year flood in each of the region's subwatersheds are summarized in Table 5.11 and Figure 5.9.

TABLE 5.11 - PRESENT FLOOD DAMAGES^{1/}

Subwatershed	100-Year Flood Damage	Average Annual Damage
-Parker River Watershed-		
PA-2 (Little River)		2/
PA-3 (Parker River)		2/
-Ipswich River Watershed-		
IP-4 (Ipswich River)	2,020,000	121,200
-North Shore Watersheds-		
NS-5 (Annisquam River)	115,800	20,900
NS-6 (Danvers River)	517,800	93,100
NS-7 (Saugus River)	1,635,000	179,800
NS-8 (Mystic River)	108,000	19,400
-Neponset River Watershed-		
NE-17 (Neponset River)		2/
NE-18 (Diamond-Traphole Brooks)	1,379,000	169,100
NE-19 (Neponset River)	73,000	8,100
NE-20 (Neponset River)	600,000	36,000
NE-21 (Pine Tree Brook)		2/
NE-22 (Neponset River)	5,675,000	624,200
-South Shore Watersheds-		
SS-23 (Town River)	4,385,000	482,500
SS-24 (Monatiquot River)	355,200	21,400
SS-25 (Smelt Brook)		2/
SS-26 (Weir River)		2/
SS-27 (North River)		2/
SS-28 (South River)		2/
SS-29 (Jones River)		2/
SS-30 (Eel River)		2/
SS-31 (Cape Cod Canal)		2/
-Taunton River Watershed-		
TA-47 (Town River)		2/
TA-48 (Matfield River)	437,400	26,300
TA-49 (Shumatuscacant River)		2/
TA-50 (Winnetuxet River)		2/
TA-51 (Taunton River)		2/
TA-52 (Taunton River)	182,400	10,900
TA-53 (Nemasket River)		2/
TA-54 (Mill River)	122,600	7,300
TA-55 (Rumford River)		2/
TA-56 (Threemile River)	835,800	50,200
TA-57 (Taunton River)		2/
TA-58 (Assonet River)		2/
-Narragansett Bay Watersheds-		
NB-59 (Palmer River)		2/
NB-60 (Ten Mile River)	2,049,600	367,900
NB-71 (Quequechan River)		2/
NB-72 (Cole River)		2/
-Buzzards Bay Watersheds-		
BB-41 (Agawam River)		2/
BB-42 (Weweantic River)	488,000	88,000
BB-43 (Crane Brook)		3/
BB-44 (Mattapoisett River)		2/
BB-45 (Acushnet River)	211,800	38,200
BB-76 (West River)		2/
-Cape Cod & Islands-		
All Cape Cod and Islands subwatersheds have less than \$5,000 in average annual damage.		

^{1/} Price Base 1976.^{2/} Average Annual Damage less than \$5,000.^{3/} Crane Brook damage figures have been included with those for Weweantic River.

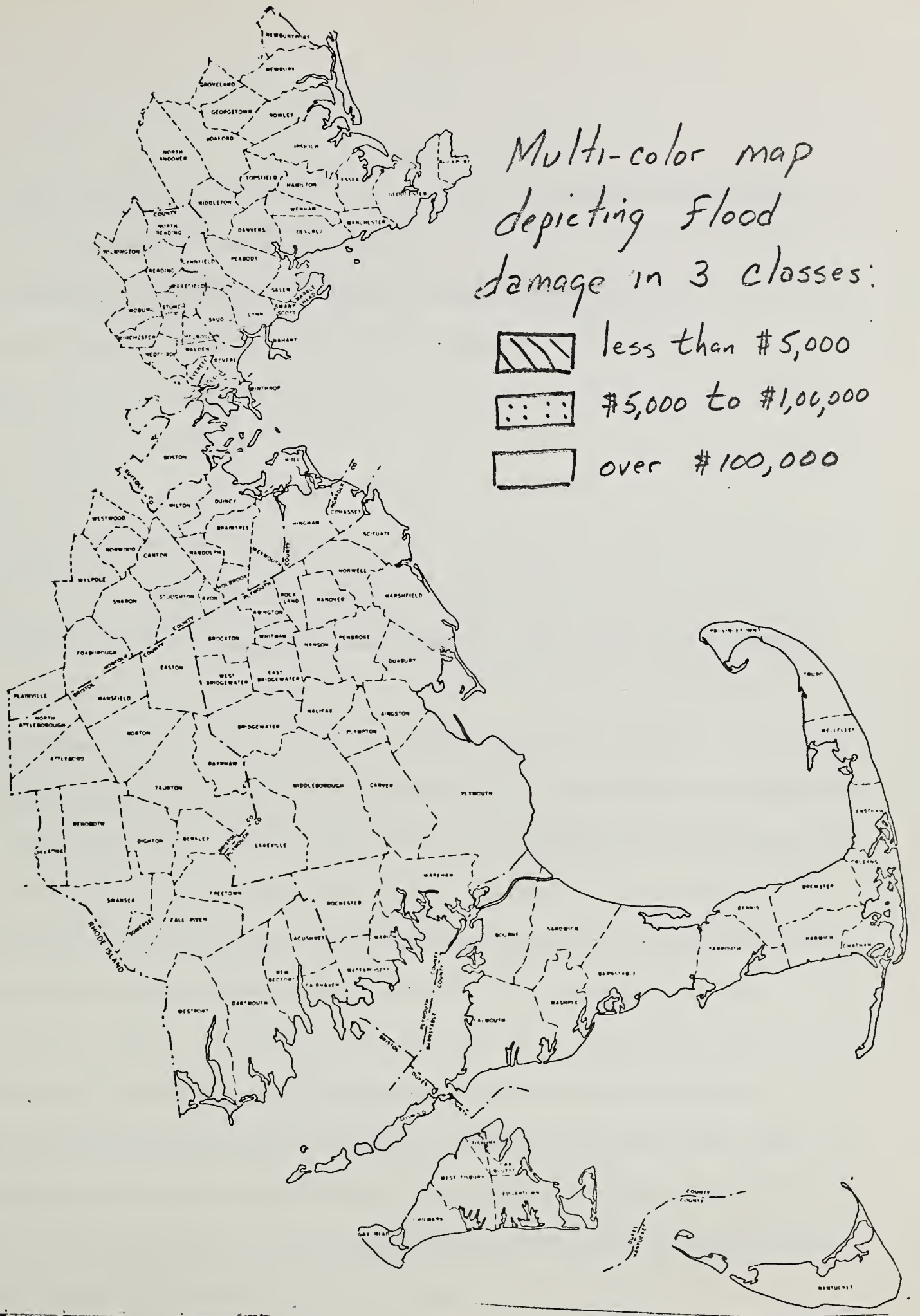


Figure 5.9
Flood Damage (Average Annual)

5.4 EROSION AND SEDIMENT

Soil erosion results from the action of moving water, wind, gravity, frost, or a combination of these forces on the land. The main concerns in the region are water-activated erosion and its by-product--sedimentation. In addition, natural or geologic erosion should be differentiated from accelerated erosion.

"Natural or geologic erosion is a continuing process and will go on into the future regardless of anything man can do. Quickening of the pace of erosion, owing to changes wrought by man, has produced definitely abnormal conditions. Accelerated erosion, an abnormal and undesirable process, was started by man's activities and is subject to his control."

Sheet, rill, gully, stream and roadbank erosion occur in the region; but, in general, the erosion rate is low in comparison to the southern or western portions of the United States.

Erosion is not only a problem in itself, but also serves as a source for sediment. When erosion occurs, the eroded material will usually create a second problem when deposited in stream channels, reservoirs, lakes, wetlands, and rivers. Along with the individual soil particles which constitute sediment, any fertilizer, pesticides, animal waste, or other organic matter attached to or adjacent to the soil particles is also carried off. The net result is possible impairment of stream water quality.

Erosion and sediment problems have historically been corrected with land treatment measures which are the application of a combination of practices

that will meet specific objectives. These objectives include controlling soil erosion, decreasing runoff of rainfall, improving soil and plant productivity, improving wildlife habitat, and improving environmental quality. The practices are classified as management, vegetative and cultural, or mechanical.

Mechanical practices include diversions, terraces, waterways, outlets and small grade stabilization structures. These practices are designed to reduce erosion by reducing the length of slope and by providing proper courses for transporting the water at nonerosive velocities. When used with vegetative practices, mechanical practices can be extremely effective in reducing erosion.

Examples of vegetative and cultural practices are: conservation cropping systems, cover cropping, contour strip cropping, and planting of grasses, legumes, shrubs, and trees on critical areas. These practices protect the soil from the impact of raindrops, reduce runoff, and reduce the contact between soil particles and flowing water.

Minimum tillage, forest watershed management, timber stand improvement, timely field operations, proper grazing use, recreation and wildlife area management, and maintenance operations are all examples of management practices. These practices minimize the overuse of the land while, at the same time, improve the condition of the cover.

For forestland, land management and treatment measures can be applied through cooperative federal, state, and local efforts. One objective is to protect and improve watershed conditions that will control surface runoff, thereby reducing excessive erosion and sedimentation. Effective measures include forest fire protection, planting vegetation on exposed soils, skid trail and logging road stabilization, and leaving tree buffer strips by streambanks.

Winter logging should be encouraged, where protection of other land values is critical, since disturbance to the forest floor is less likely to occur during this time of year when the soil is frozen.

As mentioned, land treatment is planned for other objectives besides erosion control, but adequate protection of the soil is of primary importance. Land treatment has been found to be as effective in urban applications as it is in the rural sector.

In addition to land treatment, land use planning and structural measures are also applied to minimize erosion. Land use planning can be developed to guide the use, growth and development of land in the cities and towns. Land subject to excessive erosion can be converted to other land uses which have a lower erosion rate. Areas such as flood plains and steep slopes can be managed to reduce erosion and sediment damage.

Structural measures can be designed and used to protect the land from erosion and sediment. Some of the appropriate measures are debris basins, riprapping, channel improvements, and grade stabilization structures. Erosion and sedi-

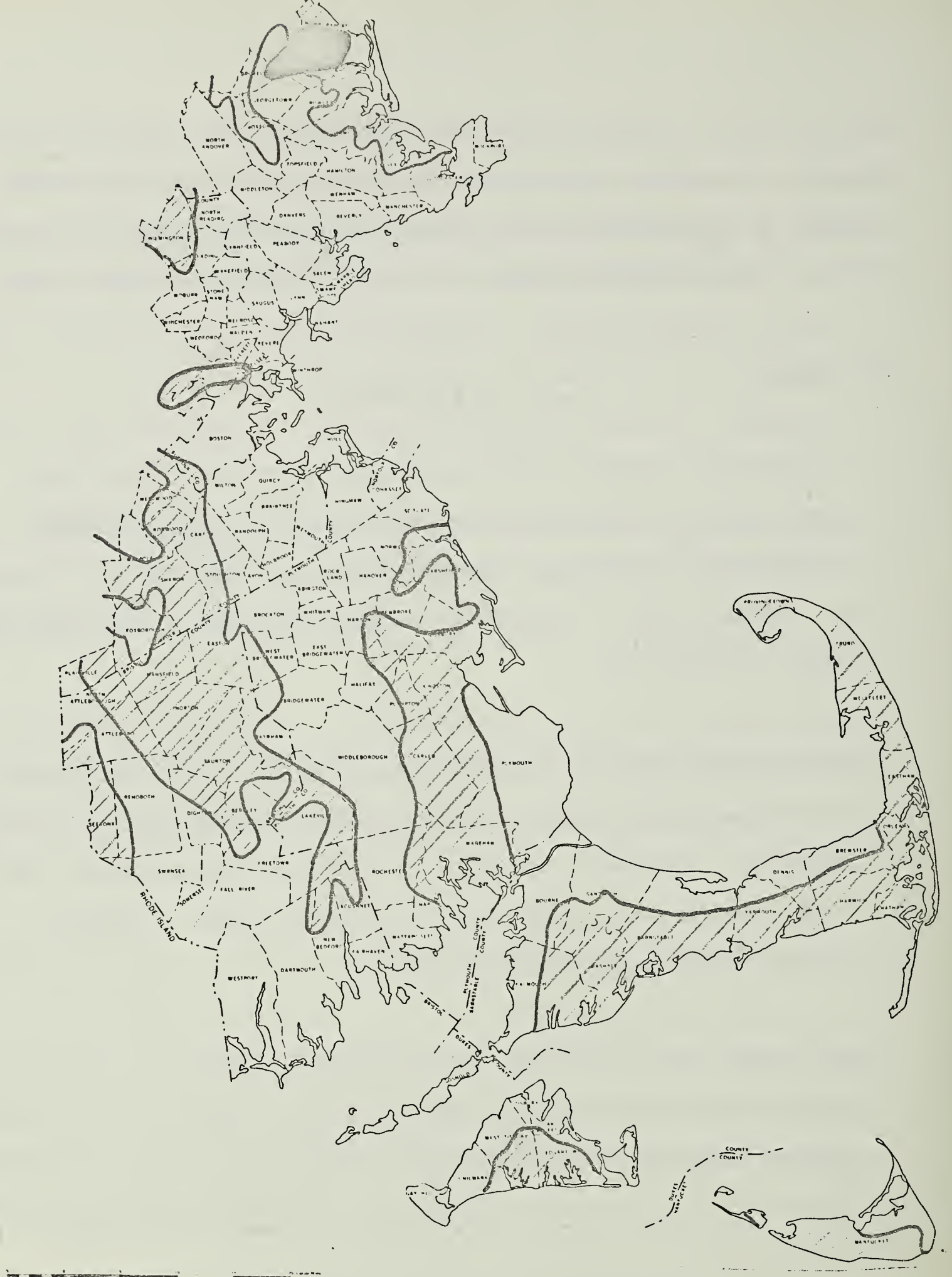
mentation can be reduced by decreasing high stream flows with flood control measures. Impoundments and natural storage basins will also collect the sediment in the stream and reduce sediment deposits downstream. The water quality in the stream should also be improved by reducing sediment loads.

A. Erosion

To assess the extent of erosion and sediment problems in the Coastal Region, the land area was divided into three types based on general susceptibility to erosion. These "Erosion Land Types" were: 1. upland; 2. terrace; and 3. flood plain. Location and extent of the types are shown on Figure 5.10.

Based on the judgement of Soil Conservation Service field technicians, the following types of areas were thought to represent the major erosion potential: farmland in cultivation, forestland being harvested, road-banks, unpaved roads, gravel pits, construction areas, streambanks, utility rights-of-way, and sand dunes.

Sand dunes with insufficient vegetative cover or which are situated in areas subject to storm erosion were identified as problems in the Coastal Region, especially on the South Shore and Cape Cod. Another related problem is the loss of coastal shoreline, due to the inherent dynamics of



LEGEND




-  FLOOD PLAIN TYPE
-  TERRACE TYPE
-  ISLAND TYPE

Figure 5.10
EROSION LAND TYPE MAP

material redistribution along the New England coast. Some areas are continually losing material which is transported by currents to other areas of shoreline which are being built-up.

The Massachusetts Office of Coastal Zone Management has completed a series of citizen-initiated maps which inventory and assess coastal erosion areas. The New England Division of the Army Corps of Engineers has also prepared a number of publications assessing coastal erosion problems in specific areas along the Massachusetts coast.

Those erosion problems which are directly related to the forces of the ocean were considered to be instances where little assistance could be provided in the way of alternatives to reduce the problem. Expensive structural measures are usually required to control wave-induced erosion. In many cases, coastal erosion control in one area results in aggravation of erosion and adjacent areas which are "starved" for sand to replace eroded material. Thus, the construction of a groin or bulkhead to solve a local erosion problem may be the start of a series of construction efforts, as the erosion problem is shifted. Likewise, the erosion of many sand dunes is accelerated by wave action undermining the toe of the dune, causing slipping of material, and loss of vegetation. Minimizing the erosion of the dune often requires structural measures to protect the toe of the dune from wave action with many of the same consequences as described for other structural measures in wave areas. For these reasons, the problem of erosion due to the forces of the ocean was deemed beyond

the scope of this study. In the majority of cases, the "solution" to this erosion problem rests with proper land use that recognizes the dynamic nature of the land-water interface.

Sand dunes which are not affected by the ocean waves have a better chance of being stabilized by tried and proven methods. Well-vegetated dunes tend to resist erosion. Only when the vegetation is killed by foot or vehicle traffic is the dune likely to be susceptible to wind erosion. Many of the sand dunes in the Coastal Region are in a constant state of flux. Foot paths or motor bike trails serve as a source for wind-blown sand. Nearby, vegetation traps the blowing sand, resulting in a new dune configuration. If traffic is controlled, vegetation eventually moves in to heal the eroded area. The healing process can be hastened by planting new vegetation on eroding areas. The Massachusetts Department of Environmental Management has established a nursery in Myles Standish State Forest to provide municipalities with a source for beachgrass to revegetate eroding dunes. Landowners can obtain beachgrass stock from commercial sources. Many coastal communities are utilizing vegetation, sand fence, and discarded Christmas trees to control wind erosion on sand dunes. In many cases, these low cost measures, when combined with restrictions on foot and vehicular traffic, are quite effective in reducing or controlling wind erosion.

Other potential erosion problem areas were studied, using a sampling basis to determine the extent of the erosion. Samples were made in each of the three "Erosion Land Type" areas. Soil Conservation Service techni-

cians visited known problem farms to quantify the erosion. Gravel pits and construction areas were also selected, based on known problems, or areas which appeared to have potential problems. Forestland erosion rates were estimated by Forest Service personnel. Erosion from roadbanks, unpaved roads, streambanks, and utility rights-of-way was estimated by inventorying the problems noted along a specified length of sample reach.

These erosion samples and case studies formed the basis for calculating erosion rates for the various problem types in each Erosion Land Type. The MacConnell's Massachusetts Map Down series was used to determine the number of acres in various land uses in each Erosion Land Type.

Adjustments were made to account for sampling methods and different cropping patterns to arrive at the average rates presented in Table 5.12.

Because of the great variability of coastal erosion rates, no attempt was made to calculate the erosion volume from this source. Losses of shoreline can range from nothing to more than 10 feet per year. Some parts of the shore are experiencing accretion of material which was eroded from another portion of the coastline. Differences are primarily a function of the shoreline material, prevailing currents, predominant wind direction, and degree of shelter from storms.

Two of the areas originally thought to be serious erosion problems were found, upon field examination, to be rather minor.

TABLE 5.12

COASTAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acres)	Annual Erosion (tons)
<u>Coastal Region</u>			
1. Tilled Cropland	13,874	4.3	60,390
2. Other Agricultural Land	93,372	0.2	17,630
a. Orchards, bushfruit, nurseries	2,726	0.2	(620)
b. Cranberry bogs	19,537	0	(0)
c. Pasture, hayland, unused tilled	71,109	0.2	(17,012)
3. Abandoned orchards, abandoned fields, power line rights-of-way	83,782	0.3	21,560
4. Forest	779,046	0.1	83,400
5. Wetlands, wooded swamps (nonsediment producing)	199,282	0.	0
6. Urban	401,092	0.3	121,250
7. Construction sites (annual)	9,448	36.	340,130
Land Erosion - Total	1,579,896	0.4	644,360
8. Streambanks susceptible to erosion	(miles)	(tons/mile)	
Major Streams	103	66	6,831
Tributaries	208	166	34,487
Total Erosion			685,678
<u>Barnstable County</u>			
1. Tilled Cropland	207	4.1	840
2. Other Agricultural Land	6,539	0.2	1,220
a. Orchards, bushfruit, nurseries	174	0.3	50
b. Cranberry bogs	2,526	0	0
c. Pasture, hayland, unused tilled	3,832	0.3	1,170
3. Abandoned orchards, abandoned fields, power line rights-of-way	16,015	0.3	4,810
4. Forest	150,314	0.1	15,030
5. Wetlands, wooded swamps (nonsediment producing)	21,836	0	0
6. Urban	56,580	0.3	16,970
7. Construction sites (annual)	1,874	36.	67,460
Land Erosion - Total	253,355	0.4	106,330
<u>Bristol County</u>			
1. Tilled Cropland	7,040	4.4	30,730
2. Other Agricultural Land	31,930	0.2	6,409
a. Orchards, bushfruit, nurseries	618	0.2	120
b. Cranberry bogs	818	0	0
c. Pasture, hayland, unused tilled	30,494	0.2	6,285
3. Abandoned orchards, abandoned fields, power line rights-of-way	17,164	0.2	3,430
4. Forest	168,086	0.1	16,809
5. Wetlands, wooded swamps (nonsediment producing)	50,713	0	0
6. Urban	73,966	0.3	22,190
7. Construction sites (annual)	1,583	36.	56,990
Land Erosion - Total	350,482	0.5	136,560

TABLE 5.12

COASTAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acres)	Annual Erosion (tons)
<u>Dukes County</u>			
1. Tilled Cropland	75	4.0	300
2. Other Agricultural Land	2,678	0.3	810
a. Orchards, bushfruit, nurseries	7	0.3	2
b. Cranberry bogs	7	0	
c. Pasture, hayland, unused tilled	2,664	0.3	803
3. Abandoned orchards, abandoned fields, power line rights-of-way	7,238	0.3	2,170
4. Forest	47,708	0.1	4,770
5. Wetlands, wooded swamps (nonsediment producing)	2,146	0	0
6. Urban	5,039	0.4	2,020
7. Construction sites (annual)	167	36.	6,010
Land Erosion - Total	65,051	0.3	16,080
<u>Essex County</u>			
1. Tilled Cropland	1,737	4.1	7,210
2. Other Agricultural Land	14,117	0.2	2,940
a. Orchards, bushfruit, nurseries	802	0.2	160
b. Cranberry bogs	0	0	0
c. Pasture, hayland, unused tilled	13,315	0.2	2,780
3. Abandoned orchards, abandoned fields, power line rights-of-way	9,526	0.2	1,910
4. Forest	94,288	0.15	14,143
5. Wetlands, wooded swamps (nonsediment producing)	40,524	0	0
6. Urban	61,444	0.3	18,430
7. Construction sites (annual)	1,449	36.	52,160
Land Erosion - Total	223,085	0.4	96,790
<u>Middlesex County</u>			
1. Tilled Cropland	105	4.5	470
2. Other Agricultural Land	719	0.2	150
a. Orchards, bushfruit, nurseries	251	0.2	50
b. Cranberry bogs	11	0	0
c. Pasture, hayland, unused tilled	457	0.2	104
3. Abandoned orchards, abandoned fields, power line rights-of-way	1,921	0.2	380
4. Forest	15,640	0.15	2,350
5. Wetlands, wooded swamps (nonsediment producing)	8,147	0	0
6. Urban	32,941	0.3	9,880
7. Construction sites (annual)	516	36.	18,580
Land Erosion - Total	59,989	0.5	31,810

TABLE 5.12

COASTAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acres)	Annual Erosion (tons)
<u>Nantucket County</u>			
1. Tilled Cropland	88	3.9	340
2. Other Agricultural Land	1,099	0.2	228
a. Orchards, bushfruit, nurseries	0	-	0
b. Cranberry bogs	349	0	0
c. Pasture, hayland, unused tilled	750	0.3	228
3. Abandoned orchards, abandoned fields, power line rights-of-way	11,543	0.3	3,460
4. Forest	11,023	0.1	1,100
5. Wetlands, wooded swamps (nonsediment producing)	2,263	0	0
6. Urban	4,152	0.4	1,660
7. Construction sites (annual)	150	36.	5,400
Land Erosion - Total	30,318	0.4	12,190
<u>Norfolk County</u>			
1. Tilled Cropland	290	3.9	1,150
2. Other Agricultural Land	3,805	0.2	860
a. Orchards, bushfruit, nurseries	239	0.2	50
b. Cranberry bogs	36	0	0
c. Pasture, hayland, unused tilled	3,530	0.2	810
3. Abandoned orchards, abandoned fields, power line rights-of-way	6,026	0.2	1,210
4. Forest	61,144	0.1	6,114
5. Wetlands, wooded swamps (nonsediment producing)	15,700	0	0
6. Urban	53,975	0.3	16,190
7. Construction sites (annual)	1,111	36.	40,000
Land Erosion - Total	142,051	0.5	65,510
<u>Plymouth County</u>			
1. Tilled Cropland	4,332	4.5	19,350
2. Other Agricultural Land	32,333	0.1	4,980
a. Orchards, bushfruit, nurseries	585	0.3	180
b. Cranberry bogs	15,790	0	0
c. Pasture, hayland, unused tilled	15,958	0.3	4,810
3. Abandoned orchards, abandoned fields, power line rights-of-way	13,245	0.3	3,970
4. Forest	228,697	0.1	22,870
5. Wetlands, wooded swamps (nonsediment producing)	56,523	0	0
6. Urban	81,602	0.3	24,480
7. Construction sites (annual)	2,565	36.	92,340
Land Erosion - Total	419,297	0.4	167,990

TABLE 5.12

COASTAL REGION EROSION DATA

Land Use	Area (acres)	Annual Erosion Rate (tons/acres)	Annual Erosion (tons)
<u>Suffolk County</u>			
1. Tilled Cropland	0	-	0
2. Other Agricultural Land	159	0.2	30
a. Orchards, bushfruit, nurseries	50	0.2	10
b. Cranberry bogs	0	0	0
c. Pasture, hayland, unused tilled	109	0.2	22
3. Abandoned orchards, abandoned fields, power line rights-of-way	1,104	0.2	220
4. Forest	2,146	0.1	210
5. Wetlands, wooded swamps (nonsediment producing)	1,430	0	0
6. Urban	31,396	0.3	9,420
7. Construction sites (annual)	33	36.	1,190
Land Erosion - Total	36,268	0.3	11,070

Gravel pits and earth removal operations, with their disruption of vegetation and steep side slopes, were felt to be potential erosion and sediment problems. Examination showed that, although erosion of side slopes was indeed a severe problem in terms of the volume of soil being moved, little or no material left the actual gravel pit, thus eliminating the sediment problem off-site. It seems that what appeared to be a major source of sediment was not a problem beyond the limits of the removal operation and is probably not even a "problem" to the pit operator.

Nearly 80 percent of the communities in the region have bylaws which regulate gravel pits and earth removal activities. These communities are shown on Figure 5.11. The bylaws and regulations are designed to limit the off-site effects of earth removal activities and seem quite successful in accomplishing their intended purpose.

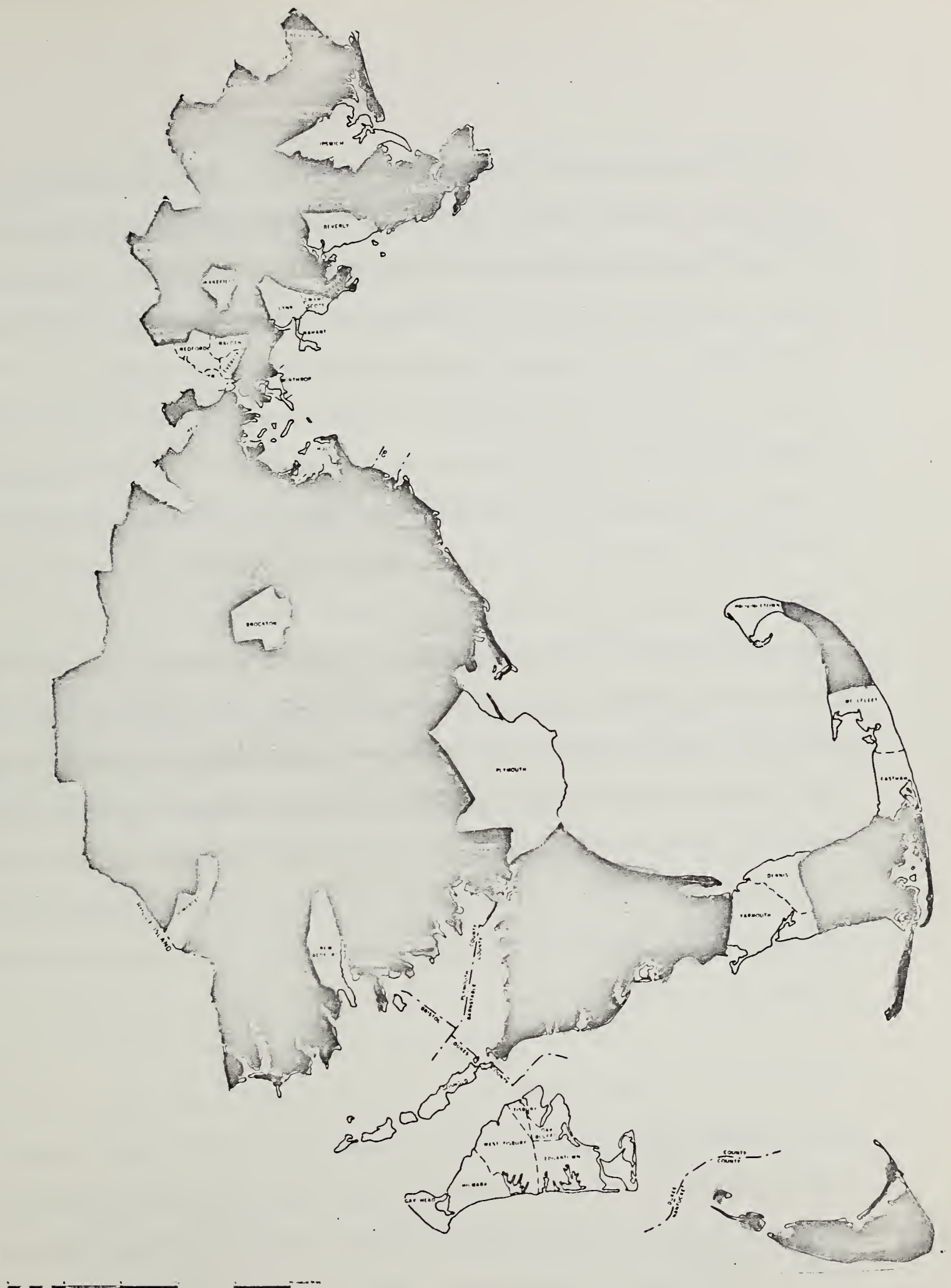


Figure 5.11

COASTAL REGION COMMUNITIES WITH BY-LAWS TO
REGULATE GRAVEL PITS & EARTH REMOVAL ACTIVITIES

The most noticeable off-site erosion problem from gravel pits is an aesthetic or visual quality deterioration which results when wind storms erode fine-grained material. The material is often carried from the pit area and creates a nuisance situation for nearby residents. The problem is usually localized in the vicinity of the gravel pit area.

Another potential problem concern was removed after the field sampling program. Erosion along roadways was an erosion area often mentioned in discussions with local leaders and Soil Conservation Service personnel. Sampling of more than 100 miles of roadway resulted in the collection of a stack of sampling forms with the notation "No Problem." In the few cases where problems were noted and quantified, the field observer estimated the eroded volume in the 5-10 cubic yard range. When this volume was adjusted for the length of sample reach and further reduced by computing an annual rate of erosion, the small numbers were insignificant. This is not to say that severe isolated cases of roadbank erosion do not exist, but when found, they represent a small percentage of the total roadbank mileage.

Although total gross erosion from urban and "other" land areas is high (121,000 tons per year), the rate of erosion is quite low (0.3 ton per acre). The basic reason for the high total erosion is the large area in urban and "other" land use (400,000 acres). The erosion rate for urban land is considered to be acceptably low, and no further action is needed to reduce the rate.

The areas with the highest erosion rates were found to be urbanizing areas which were under construction. The average erosion rate for construction sites was estimated to be 36 tons per acre. This figure varies enormously depending on such factors as site topography, slope, construction practices, and time of year, but the 36-tons per acre represent a good average value for the region. Construction areas have the highest rates of erosion since, by their very nature, they involve the removal of protective vegetation and exposure of bare soil to the eroding effects of wind and, more importantly, water.

Good erosion control practices during construction can do much to reduce erosion problems, and reduce the rate of erosion. The Soil Conservation Service has prepared a publication entitled "Guidelines for Soil and Water Conservation in Urbanizing Areas of Massachusetts" which details some of the construction practices. Erosion control measures during construction add minimally to the total construction cost; however, many contractors and owners are reluctant to spend money for "nonconstruction" type measures. To control erosion during construction, a small number of communities have adopted sediment and erosion control bylaws.

Erosion losses from tilled cropland represent the second highest erosion volume in the region. The average erosion rate of 4.3 tons per acre exceeds the average allowable erosion rate of 3 tons per acre by over 40 percent. Topsoil is a valuable natural resource containing most of the soil organic matter and the nutrients required by plants for crop

production. Soil scientists estimate that to maintain productivity over time, annual soil losses on most Massachusetts' agricultural soils must be limited to no more than 3 tons per acre.

The average erosion rate for tilled cropland in the Coastal Region of 4.3 tons per acre is not extremely excessive. There are, however, individual farms which have critical erosion problems and extremely high rates of erosion loss. Bristol and Plymouth Counties account for approximately 80 percent of the tilled cropland erosion in the region.

As noted in Table 5.8, a relatively high percentage of the farming in the Coastal Region is taking place on soils other than prime farmland soils, or soils of state and local importance for farming. These "other" soils which are being farmed often have serious erosion problems resulting from steep slopes or the naturally high erodibility of soil type.

Establishment and maintenance of good conservation practices by the majority of the region's farm operators have done much to reduce total erosion from farmland. However, more needs to be done by the minority of farmers who have severe erosion problems on their land.

Sampling and surveys have shown that erosion from wetlands, cranberry bogs, pasture, forest, orchards, abandoned fields, and established urban areas is not a serious problem.

Streambank erosion is a relatively minor problem, as compared to that experienced in the other parts of Massachusetts. The relatively low stream gradients and slow moving streams are the main reason for the low streambank erosion.

Since sampling showed that Bristol and Plymouth Counties accounted for over half of the total land erosion in the region, an inventory of critical erosion areas was made for these counties and Barnstable County. Results of the inventory are presented in Table 5.13.

B. Sediment

If the entire volume of erosion in the region were to result in sediment which was delivered to streams and rivers, the results would be catastrophic. Fortunately, a large percentage of the erosion products from land areas are deposited on land before reaching a watercourse. Stone walls, fences, strips of vegetation, forestland, and even flat slopes cause the erosion products to be deposited. Delivery rates of sediment to streams may be 10 percent or less of the original eroded volume.

On the other hand, erosion from streambanks results in a very high percentage of eroded material becoming sediment, which pollutes the stream. Cobbles and boulders usually remain fairly close to their original location, sand may settle out in the flat stretches of streams and in pools, but the fine sand and silt fraction remains as suspended sediment to

TABLE 5.13 - CRITICAL EROSION AREA INVENTORY

Municipality	Number of Critical Erosion Areas Inventoried					Total
	Roadbank	Gravel Pits ^{1/}	Cropland	Urban Development	Other	
<u>Bristol County</u>	12	130	43	9	3	197
Acushnet		6	5			11
Attleboro	6	8		1		15
Berkley		10	1	2		13
Dartmouth		12	3			15
Dighton		5	1			6
Easton		5	1			6
Fairhaven		2	1			3
Fall River	1					1
Freetown		17	2			19
Mansfield	2	8	4	2		16
New Bedford		3				3
North Attleborough	1	10	2			13
Norton		5	1	1		7
Raynham		8	1			9
Rehoboth	1		5		2	8
Seekonk	1	5	4			10
Somerset						0
Swansea		2				2
Taunton		9	2	3		14
Westport		15	10		1	26
<u>Barnstable County</u>	10	58	0	11	0	79
Barnstable		6		1		7
Bourne	4	6		4		14
Brewster	3			1		4
Chatham						0
Dennis		6				6
Eastham		3				3
Falmouth		13				13
Harwich	1	5				6
Mashpee				3		3
Orleans						0
Provincetown		1				1
Sandwich	1	6		1		8
Truro		5				5
Wellfleet		4				4
Yarmouth	1	3		1		5
<u>Plymouth County</u>	1	61	38	12		112
Abington						0
Bridgewater		1	4	1		6
Brockton						0
Carver		6	1	1		8
Duxbury		3				3
East Bridgewater		1	1	1		3
Halifax		3	12			15
Hanover		1		2		3
Hanson		1		1		2
Hingham						0
Hull						0
Kingston		3				3
Lakeville		3	2			5
Marion		2				2
Marshfield		2				2
Mattapoisett		5				5
Middleborough		7	6	1		14
Norwell		3				3
Pembroke		4				4
Plymouth		1		4		5
Plympton		1	2	1		4
Rochester		5	2			7
Rockland						0
Scituate			2			2
Wareham	1	9	1			11
West Bridgewater			5			5
Whitman						0

^{1/} Although gravel pits represent a critical erosion area, they have few off-site effects. Therefore, erosion control measures will serve to improve aesthetics of the area but are not necessary to solve off-site sediment or other common "erosion and sediment" problems.

dirty the water and reduce its attractiveness as fish habitat and as habitat for insects in the fish food-chain.

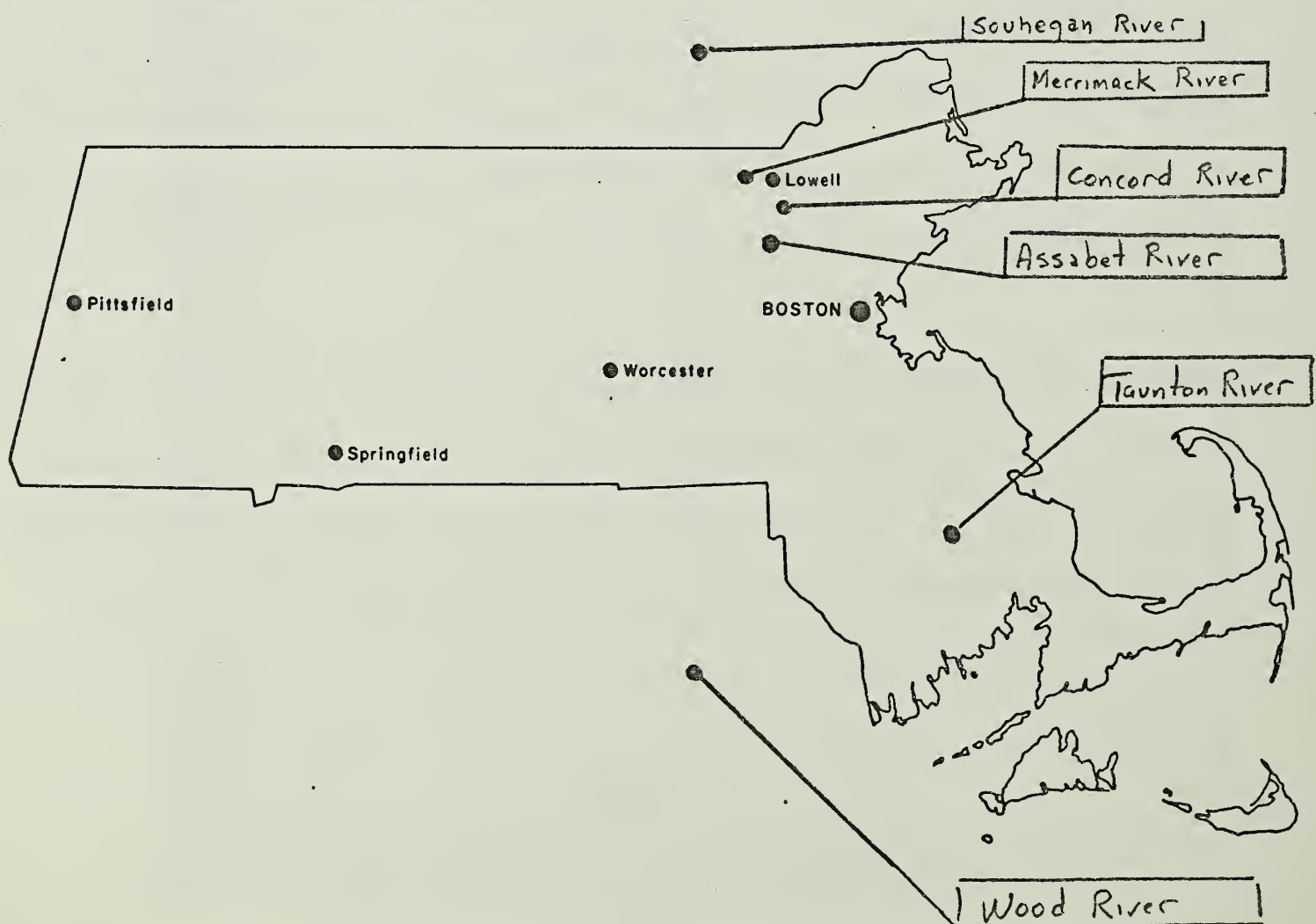
Suspended sediment measurement stations have been established throughout Massachusetts by the U.S. Geological Survey. These stations are located on major streams and monitor suspended sediment at the USGS stream gage locations. Station locations and pertinent data are indicated on Figure 5.12.

Flow-duration data combined with suspended sediment readings were used to prepare Average Annual Sediment data for each station. Although the data has significant scatter, it does present an envelope of values to quantify the suspended sediment situation. The range of values is between 0.015 ton/acre and 0.155 ton/acre. There appears to be little correlation between the size of drainage area and the amount of suspended sediment per unit area. Factors such as upstream dams which act as traps for some of the larger sized sediments were not included in the calculation.

Based on the analysis of suspended sediment data and estimates of quantities of the larger sized "bedload" sediment, it is estimated that total annual sediment in the rivers and streams of the region is approximately 69,000 tons or about 10 percent of the total erosion in the region.

FIGURE 5.12
SEDIMENT ESTIMATES AT SELECTED STREAM GAGES

Stream Gage (USGS Gage No.)	Drainage Area (sq. miles)	Suspended Sediment (tons/sq. mile)	Total Sediment (tons/sq. mile)
Taunton River near Bridgewater, Massachusetts (01108000)	260	37	40
Wood River near Arcadia, Rhode Island (01117800)	35.2	12	14
Merrimack River above Lowell, Massachusetts (01096550)	4,635	53	56
Concord River at Lowell, Massachusetts (01099500)	405	13	16
Assabet River at Maynard, Massachusetts (01097000)	116	7	10
Souhegan River New Hampshire (01094000)	171	21	24



5.5 WETLANDS

Wetlands are those areas where the water table is at or near the ground surface for much of the year and which are subject to occasional flooding. The soils of the wetlands are usually poorly or very poorly drained, except for seasonally flooded flats. These are usually alluvial or flood plain soils which may have better drainage.

See Table 5.14, Area of Wetlands, for a summary of wetland acreage in the region's municipalities. The wetland figures do not include flood plain lands that are dry most of the year, although these usually-dry portions of flood plains are in the same jurisdictional category as wetlands in Massachusetts' wetland legislation. The approximately 159,500 acres of inland wetlands in the region represents 9.5 percent of the total area. Fresh and saltwater wetlands combined represent 11.9 percent of the region's land area. The range is from zero percent in Chelsea to over 42 percent in Wilmington.

Wetlands are important for flood control, wildlife habitats, and to a lesser degree for water quality, and groundwater aquifer protection, recreation and visual quality. In addition, wetlands are extremely poor sites for industrial, commercial, and residential development because of high water tables, the flooding hazard, and the possibility of organic materials in the soils underlying the foundation. High water tables eliminate the use of septic tank and leach field systems for onsite sewage disposal, create serious site drainage

problems, and make the use of building basements impractical and often impossible. The presence of organic material--muck or peat--in a foundation often results in differential settlement and cracking of the structure or fill. Removal of mucks and peats, particularly deep deposits, is usually a necessity for all but the lightest of fills or structures.

Wetlands act as natural floodwater retarding basins which store floodwaters and, thus, lower downstream peak flood flows. Loss of these storage areas can result in higher flood peaks and more extensive flooding downstream.

TABLE 5.14 - WETLAND REGIONAL SUMMARY

SUBREGION	Acres of Wetlands					
	Inland Wetlands			Fresh Open Water ^{1/}	Salt Marshes	Total
	Open Wet- lands	Wooded Swamps	Total			
Northeast	11,031	33,238	44,269	8,185	15,678	68,132
Southeast	23,062	80,602	103,664	29,685	10,375	143,724
Cape and Islands	8,139	3,441	11,580	14,110	14,665	40,355
TOTAL	42,232	117,281	159,513	51,980	40,718	252,211

^{1/} Does not include river water areas.

Many wildlife species depend directly on wetlands for food and habitat. As a result, wetlands provide many opportunities for recreational activities, such as hunting and wildlife observation.

TABLE 5.15

MASSACHUSETTS WATER RESOURCES STUDY

WETLAND AREAS
COASTAL REGION

Municipality	Open Type Wetlands (Acres)	Wooded Swamps (Acres)	Fresh Open Water (Acres)	Total Inland Wetland (Acres)	Saltwater Wetlands (Acres)	Total Wetlands (Acres)	Wetlands as Percent of Municipality
<u>NORTHEASTERN SECTION</u>							
<u>North Shore Study Area</u>							
Beverly	138	320	172	630	42	672	6.8
Chelsea	0	0	0	0	0	0	0
Danvers	346	331	389	1066	57	1123	12.9
Essex	439	550	105	1094	1867	2961	31.7
Everett	4	0	0	4	15	19	0.8
Gloucester	213	650	333	1196	878	2074	12.2
Lynn	65	68	311	444	34	478	6.5
Lynnfield	445	1527	212	2184	0	2184	32.2
Malden	0	43	10	53	0	53	1.6
Manchester	89	226	11	326	46	372	7.5
Marblehead	38	20	0	58	11	69	2.4
Medford	19	0	223	242	0	242	4.3
Melrose	7	22	51	80	0	80	2.6
Nahant	12	0	0	12	0	12	1.6
Peabody	345	240	257	842	7	849	7.9
Revere	31	22	82	135	506	641	15.8
Rockport	102	156	78	336	49	385	8.3
Salem	171	52	53	276	40	316	5.3
Saugus	126	196	330	652	685	1337	18.3
Stoneham	55	48	397	500	0	500	11.5
Swampscott	34	5	8	47	0	47	2.4
Wakefield	170	526	341	1037	0	1037	20.3
Winchester	37	28	182	247	0	247	6.1
Winthrop	4	0	14	18	35	53	4.2
Woburn	302	490	173	965	0	965	11.7
<u>Ipswich Study Area</u>							
Boxford	316	1830	403	2549	0	2549	16.2
Hamilton	369	2059	254	2682	43	2725	28.5
Ipswich	605	2175	168	2948	4007	6955	30.0
Middleton	457	1285	214	1956	0	1956	21.0
North Andover	428	1737	714	2879	0	2879	16.1
North Reading	427	1080	0	1507	0	1507	17.4
Reading	151	1793	0	1944	0	1944	30.4
Topsfield	757	1065	78	1900	0	1900	23.2
Wenham	202	1196	247	1645	0	1645	30.9
Wilmington	397	2533	96	4671	0	4671	42.2

TABLE 5.15
MASSACHUSETTS WATER RESOURCES STUDY
WETLAND AREAS
COASTAL REGION

Municipality	Open Type Wetlands (Acres)	Wooded Swamps (Acres)	Fresh Open Water (Acres)	Total Inland Wetland (Acres)	Saltwater Wetlands (Acres)	Total Wetlands (Acres)	Wetlands as Percent of Municipality
--------------	----------------------------------	-----------------------------	-----------------------------------	---------------------------------------	----------------------------------	------------------------------	---

NORTHEASTERN SECTION

Neponset Study Area

Boston	247	242	331	820	343	1163	3.7
Canton	634	1545	399	2578	0	2578	20.7
Milton	59	285	66	410	165	575	6.8
Norwood	310	871	18	1199	0	1199	18.1
Sharon	216	2067	517	2800	0	2800	18.1
Walpole	242	1676	270	2188	0	2188	16.4
Westwood	91	745	68	904	0	904	12.7

Parker Study Area

Georgetown	200	1607	113	1920	0	1920	22.8
Groveland	229	694	166	1089	0	1089	17.9
Newbury	662	91	4	757	4592	5349	33.0
Newburyport	408	28	5	441	267	708	10.7
Rowley	432	1114	47	1593	1989	3582	28.1

SOUTHEASTERN SECTION

South Shore Study Area

Braintree	238	446	273	957	15	972	10.7
Cohasset	72	676	167	915	109	1024	16.0
Duxbury	647	692	359	1698	986	2684	17.4
Hanover	310	1115	95	1520	0	1520	15.2
Hingham	254	1705	137	2096	156	2252	15.5
Holbrook	37	655	74	766	0	766	16.1
Hull	4	0	4	8	74	82	4.5
Kingston	399	460	303	1162	140	1302	10.4
Marshfield	726	84	98	908	1977	2885	15.4
Norwell	457	1987	137	2581	140	2721	20.7
Pembroke	583	1581	1235	3399	0	3399	22.2
Plymouth	680	77	4388	5145	238	5383	8.6
Quincy	66	42	81	189	481	670	6.2
Randolph	156	366	316	838	0	838	12.8
Rockland	167	1084	54	1305	0	1305	20.3
Scituate	136	589	168	893	1225	2118	18.8
Weymouth	132	925	513	1570	167	1737	15.1

TABLE 5.15

MASSACHUSETTS WATER RESOURCES STUDY
WETLAND AREAS
COASTAL REGION

Municipality	Open Type Wetlands (Acres)	Wooded Swamps (Acres)	Fresh Open Water (Acres)	Total Inland Wetland (Acres)	Saltwater Wetlands (Acres)	Total Wetlands (Acres)	Wetlands as Percent of Municipality
--------------	----------------------------------	-----------------------------	-----------------------------------	---------------------------------------	----------------------------------	------------------------------	---

SOUTHEASTERN SECTION

Taunton Study Area

Abington	161	506	105	772	0	772	11.9
Avon	37	268	142	447	0	447	14.8
Berkley	292	1402	11	1705	0	1705	15.8
Bridgewater	586	2401	560	3547	0	3547	19.5
Brockton	156	560	87	803	0	803	5.9
Dighton	287	2188	107	2582	0	2582	18.1
East Bridgewater	553	905	192	1650	0	1650	14.8
Easton	501	1390	172	2063	0	2063	11.2
Foxborough	148	507	464	1119	0	1119	8.6
Freetown	677	2974	596	4247	4	4251	18.9
Halifax	818	1756	430	3004	0	3004	27.1
Hanson	845	1333	411	2589	0	2589	26.0
Lakeville	567	1832	3946	6345	0	6345	27.7
Mansfield	227	910	116	1253	0	1253	9.7
Middleborough	1363	6688	1827	9878	0	9878	21.3
Norton	452	2326	688	3466	0	3466	18.7
Plympton	316	1815	108	2239	0	2239	23.2
Raynham	280	1382	164	1826	0	1826	13.9
Stoughton	223	652	76	951	0	951	9.1
Taunton	858	2918	683	4459	0	4459	15.1
West Bridgewater	656	1027	51	1734	0	1734	17.5
Whitman	431	159	7	597	0	597	13.5

Buzzards Bay Study Area

Acushnet	342	1908	187	2437	40	2477	20.3
Carver	1734	1951	1248	4933	0	4933	17.9
Dartmouth	357	6106	474	6937	1149	8086	20.2
Fairhaven	29	602	19	650	675	1325	16.7
Fall River	329	3202	2824	6355	0	6355	26.0
Marion	147	618	0	765	445	1210	13.3
Mattapoisett	103	835	15	953	498	1451	13.0
New Bedford	149	1834	101	2084	0	2084	16.3
Rochester	815	3123	1551	5489	0	5489	23.8
Wareham	894	370	1031	2295	883	3178	13.4
Westport	264	2557	1288	4109	940	5049	13.6

TABLE 5.15
MASSACHUSETTS WATER RESOURCES STUDY
WETLAND AREAS
COASTAL REGION

Municipality	Open Type Wetlands (Acres)	Wooded Swamps (Acres)	Fresh Open Water (Acres)	Total Inland Wetland (Acres)	Saltwater Wetlands (Acres)	Total Wetlands (Acres)	Wetlands as Percent of Municipality
--------------	----------------------------------	-----------------------------	-----------------------------------	---------------------------------------	----------------------------------	------------------------------	---

SOUTHEASTERN SECTION

Narragansett Bay Study Area

Attleboro	555	2595	426	3576	0	3576	20.0
North Attleborough	156	343	299	798	0	798	6.3
Plainville	191	185	191	567	0	567	7.6
Rehoboth	723	3983	226	4932	0	4932	16.2
Seekonk	365	937	74	1376	0	1376	11.4
Somerset	107	9	163	279	29	308	5.0
Swansea	304	1061	146	1511	4	1515	10.4

CAPE COD and ISLANDS SECTION

Cape Cod Study Area

Barnstable	611	119	1800	2530	4023	6553	16.0
Bourne	274	43	581	898	311	1209	4.3
Brewster	501	88	1673	2262	247	2509	15.5
Chatham	525	62	260	847	964	1811	11.6
Dennis	509	235	228	972	925	1897	13.4
Eastham	118	56	175	349	1278	1627	16.0
Falmouth	324	87	998	1409	512	1921	6.1
Harwich	724	125	1035	1884	366	2250	15.6
Mashpee	294	89	1506	1889	258	2147	12.9
Orleans	164	106	183	453	599	1052	7.7
Provincetown	444	25	94	563	473	1036	15.8
Sandwich	450	95	650	1195	1002	2197	7.7
Truro	967	63	448	1478	169	1647	11.8
Wellfleet	749	222	282	1253	845	2098	15.4
Yarmouth	444	139	470	1053	1212	2265	13.8

Islands Study Area

Chilmark	52	155	948	1155	109	1264	10.6
Edgartown	123	125	1062	1310	512	1822	9.6
Gay Head	40	154	264	458	18	476	11.7
Gosnold	91	322	181	594	29	623	7.0
Nantucket	538	1017	853	2408	708	3116	9.9
Oak Bluffs	42	13	69	124	94	218	4.1
Tisbury	74	17	5	96	11	107	2.2
West Tisbury	81	84	309	474	0	474	2.8

Stream water quality can be either adversely or advantageously modified by wetlands. An example of adverse modifications can occur when wetland aquatic plants include algae, die, and decay. During this decomposition, dissolved oxygen can be lowered to inadequate levels to sustain fish and other aquatic animal life. Often, this situation is triggered by nutrient loadings from upstream domestic or industrial waste water effluents. Wetlands can also enhance water quality by acting as sediment traps and nutrient filters. The quality of the incoming water and the condition of the wetland must be known to determine how a particular wetland will effect water quality.

In the region, with the exception of Cape Cod and the Islands, the major groundwater aquifers are in the bottom lands or flood plains along or near the major streams. These aquifers are often surfaced by wetlands. A measure of protection to underlying aquifers can be provided by maintaining these wetlands.

Most inland wetlands, during normal or dry periods, act as areas of groundwater discharge. During times of flood, however, there is the possibility of recharge into groundwater storage areas through their wetlands cover. Also, the storing of floodwater in upland wetlands and the releasing of lower flows for a longer period of time from them may allow advantageous recharge conditions to develop downstream.

The Massachusetts Water Resources Study has evaluated nearly 85 of the largest inland wetlands in the Coastal Region. The wetlands were studied for their value for flood control, timber production, wetland wildlife habitat, recreation,

visual quality, and uniqueness. The methodology and criteria employed in the evaluation is discussed in Appendix B. Results of the evaluation are presented in Table 5.16. Figure 5.13 indicates the location of the wetlands which were investigated.

The wetland evaluations are not intended to be used as the sole tool to rank wetlands within the region, nor should a "Low" rated wetland be considered a prime candidate for filling and development. Rather, the ratings can be used to indicate those wetlands which are obviously important to the water resources of the region. Wetlands which are rated "High" for a number of categories should also appear high on a list of wetlands to be acquired by government, or protected by restrictions or conservation easements. Wetlands which are rated "Low" in most categories may not be too important from a water resources standpoint. However, the criteria used in evaluating the wetlands has a great effect on the final rating. There may be specific wetland characteristics which would make a low rated wetland important to a particular community or interest group. The wetland evaluation, in effect, is one aid to establishing priorities in wetlands protection. A caution needs to be reemphasized at this point. Even a wetland which rates "Low" for all evaluated purposes should not be considered suitable for development. Because of the severe limitations imposed by wet conditions, wetlands can also be rated "Low" for suitability for development. Flood hazards, year-round problems with standing water, foundation problems, and septic system failures are among the problems to be faced by those owning developed property located on former wetlands.

Public ownership and the zoning of privately owned wetlands are important facets of the wetlands picture in the region. Publicly owned wetlands are usually more secure from encroachment and development than privately owned

TABLE 5.16 - SUMMARY OF WETLAND EVALUATION RESULTS
NORTHEASTERN SECTION

Wet-land No.	Location Description	Wetland Size (Acres)	Wetland Types (Acres)							Forest Management	Flood Control	Evaluation Rating for:				
			1	2	3	4	5	6	7			Fish Habitat	Wetland Wildlife Habitat	Recreation	Unique-ness	Visual Quality
1	Little River Wetland in Newbury, West Newbury, and Newburyport, MA	500		310	110	10		30	40	Mod.	Low	N.R.	High	Mod.	High	Mod.
2	Wetland between Boxford St. and Lacy Street in North Andover, MA	440	20						420	High	Mod.	N.R.	Mod.	Low	Low	Mod.
3	Wenham Swamp in Hamilton, Topsfield & Wenham, MA	1970			130	60		300	1480	High	Mod.	N.R.	High	High	High	Mod.
4	Willowdale State Forest Wetland in Ipswich, MA	610			10	10		10	580	High	Low	N.R.	Mod.	Mod.	High	Mod.
5	Miles River Wetland in Hamilton, MA	400			30			250	120	High	Low	N.R.	High	Mod.	Low	Mod.
6	Ipswich River Wetland in Wilmington, Reading & North Reading, MA	660	40					190	430	High	High	N.R.	Mod.	Mod.	High	Mod.
7	Cedar Swamp in No. Reading, Reading & Lynnfield, MA	910			10			10	890	High	High	N.R.	Mod.	Low	High	Mod.
8	Wetland Northeast of Interchange 13 on Route 128 in Lynnfield and Wakefield, MA	480	10		60	40		330	40	Mod.	Mod.	N.R.	High	Mod.	Mod.	Mod.
9	North Lynnfield Wetland in Lynnfield, MA	220						10	210	High	Low	N.R.	Mod.	Low	Low	Mod.
10	Orne Swamp on both sides of Route 95 in Topsfield, Middleton and Boxford, MA	340		10	10			100	220	High	Low	N.R.	High	Low	Low	Mod.
11	Cedar Swamp, north of Route 128 in Manchester and Essex, MA	160						10	150	High	High	N.R.	Low	Low	Low	Mod.
12	Beaver Pond Wetland in the "Centerville" section of Beverly, MA	60					20		40	Mod.	Low	Low	Mod.	Mod.	Low	Mod.
13	Rurlington Mall Wetland in Burlington, MA	220						70	150	High	High	N.R.	Low	Low	Low	Mod.
14	Thompson's Meadow in Salem, MA	60			30	5		20	5	Low	Low	N.R.	Mod.	Low	High	Mod.
15	Swamp River Wetland in Weymouth, Hingham & Rockland, MA	280							280	High	Mod.	N.R.	Mod.	Low	Low	Mod.
16	Mine Brook Wetland in Walpole & Medfield, MA	160	40		10			10	100	High	Mod.	N.R.	Mod.	Low	High	Mod.
17	Stop River Wetland in Walpole, Norfolk & Medfield	190	70						120	High	Low	N.R.	Mod.	Low	Low	Mod.
18	Neponset River Wetland on both sides of Rte. 128 in Westwood, Canton and Dedham, MA	950	300		10	10		30	600	High	Mod.	N.R.	Mod.	Low	High	Mod.
19	Neponset River Wetland on both sides of Rte. 95 in Norwood, Canton and Sharon, MA	1800	500		30			90	1180	High	Mod.	N.R.	Mod.	Low	High	High
20	Cochato River Wetland in Holbrook, Braintree and Randolph, MA	380		5	20	10		120	225	High	Mod.	N.R.	Mod.	Mod.	Low	Mod.
21	Bear Swamp in Randolph, Stoughton & Avon, MA	230						230	230	High	High	N.R.	Mod.	Low	Low	Mod.
22	Cedar Swamp, southeast of Rte. 1A in Walpole, MA	570						20	550	High	Mod.	N.R.	High	Mod.	High	Mod.
23	Witch Pond Swamp in Foxborough and Mansfield, MA	130	5	5	5	5		10	100	High	Mod.	Low	Mod.	Mod.	Low	Mod.
24	Canoe River Wetland in Norton, Mansfield and Easton, MA	190		30				10	150	High	Mod.	N.R.	Mod.	Low	Low	High
25	Sharon Heights Wetland west of Massapoag Lake in Sharon, MA	320							320	High	Low	N.R.	Low	Low	Low	Mod.

TABLE 5.16 - SUMMARY OF WETLAND EVALUATION RESULTS
NORTHEASTERN SECTION

Wet- land No.	Location Description	Wetland Size (Acres)	Wetland Types (Acres)							Forest Manage- ment	Flood Con- trol	Fish Habi- tat	Evaluation Rating for:		
			1	2	3	4	5	6	7				Wetland Habitat	Recrea- tion	Unique-Visual ness Quality
26	North River Wetland in Norwell, Pembroke, and Marshfield, MA	650		630	10				10	N.R.	N.R.	Mod.	High	Mod.	High
27	Hockomock Swamp in Easton, West Bridgewater, Taunton, and Raynham, MA	5450	60	300	350	10	350	4380		High	High	Mod.	High	High	High
28	Beech Hill Swamp in Rockland, Hanover, and Hanson, MA	550	100							High	High	N.R.	High	Low	High
29	Deer Meadow Wetland in Whitman, MA	130						120	10	Mod.	Low	N.R.	Mod.	Low	Low
30	Great Cedar Swamp in Halifax & Hanson, MA	1470		400	180			140	750	High	Mod.	N.R.	High	High	High
31	Herring Brook Wetland in Pembroke, MA	710	90	30				120	470	High	Low	N.R.	High	High	Mod.
32	Peterson Swamp in Halifax and Plympton, MA	410						410	220	High	Low	N.R.	Mod.	Low	Mod.
33	Phillips Brook Wetland west of Rte. 3 in Duxbury	420		10	20			170		High	Mod.	Low	Mod.	Mod.	Mod.
34	Bungay River Wetland in Attleboro and North Attleborough, MA	380						20	360	High	High	N.R.	Mod.	Low	Mod.
35	Hemlock Swamp in Rehoboth, Attleboro & Norton, MA	790		10				10	770	High	Low	N.R.	Mod.	Low	Mod.
36	Chartley Brook Wetland in Attleboro & Norton, MA	600		20				130	450	High	Mod.	Low	High	High	High
37	Titicut Swamp in Bridgewater & Raynham, MA	430		30	30	20		60	460	High	Mod.	Mod.	High	High	Mod.
38	Pine Swamp in Raynham and Taunton, MA	540		20					710	High	Mod.	N.R.	Mod.	Low	Mod.
39	Great Cedar Swamp in Middleborough & Halifax, MA	720	10					220	380	Mod.	Mod.	N.R.	High	High	High
40	Winnatuxet River Wetland in Halifax & Plympton, MA	710	80	10	10			10	820	High	Low	N.R.	High	Low	Mod.
41	Turkey Swamp in Halifax and Plympton, MA	850	10					40	680	High	Mod.	N.R.	High	High	Mod.
42	Cedar Swamp in Carver, MA	750		30					620	High	Mod.	N.R.	Mod.	Low	Low
43	Manhague Swamp in Rehoboth, MA	620						10	450	High	Mod.	N.R.	Mod.	Low	Mod.
44	Squannakonk Swamp in Rehoboth, MA	460								High	Mod.	N.R.	Mod.	Low	Mod.
45	Nemasket River Wetland in Middleborough and Lakeville, MA	490	180					20	290	High	Low	Mod.	High	Low	High
46	Hobomock Swamp & Bolton Cedar Swamp in New Bedford and Freetown, MA	780		10					770	High	Low	N.R.	Mod.	Low	Mod.
47	New Bedford Reservoir Wetland in Acushnet, MA	310			80			50	180	High	Low	Mod.	High	High	Mod.
48	Rocky Gutter Brook Wetland in Middleborough, MA	1000			10			50	940	High	Mod.	N.R.	High	High	High
49	Forbes Swamp in Rochester & Middleborough, MA	560		60	10			70	420	Mod.	Low	Mod.	High	High	High
50	Cedar Swamp in Rochester, MA	690		10				40	640	High	Low	N.R.	High	Low	Mod.
51	Maple Swamp in Wareham, MA	130		40				10	80	High	N.R.	N.R.	Mod.	Low	Mod.
52	Copicut Swamp in Fall River, MA	450							450	High	Low	N.R.	Mod.	Low	Mod.
53	Shingle Island Swamp & Colebrook Swamp in Dartmouth, MA	750	10					10	730	High	Mod.	N.R.	Mod.	Low	Mod.
54	Acushnet Cedar Swamp in New Bedford, MA	1070	10		20				1040	High	Mod.	Mod.	Mod.	High	High
55	Apponagansett Swamp in Dartmouth & New Bedford	750	20					70	660	High	Mod.	N.R.	Mod.	Low	Mod.
56	Paskamansett River Wetlands in Dartmouth, MA	800		10	20			10	760	High	Low	N.R.	High	Low	High
57	Haskell Swamp in Rochester & Mattapoisett, MA	330							330	High	Low	N.R.	Mod.	Low	Mod.
58	Deerfield Swamp in Dartmouth, MA	540							540	High	Low	N.R.	Mod.	Low	Mod.

TABLE 5.16 - SUMMARY OF WETLAND EVALUATION RESULTS
NORTHEASTERN SECTION

Wet-land No.	Location Description	Wetland Size (Acres)	Wetland Types (Acres)							Forest Management	Flood Control	Evaluation Rating for:				
			1	2	3	4	5	6	7			Fish Habitat	Wetland Wildlife Habitat	Recreation	Unique-ness	Visual Quality
59	Clapps Pond Wetland in Provincetown, MA	70			20				40	10	Low	N.R.	N.R.	Mod.	Low	Mod.
60	Shank Painter Pond Wetland in Provincetown, MA	80			50	10			20		N.R.	N.R.	N.R.	High	Low	Mod.
61	Pilgrim Lake Wetland in Truro, MA	290			200				90		N.R.	N.R.	Low	High	High	Mod.
62	Little Pamet Wetland in Truro, MA	80	10		60				10		N.R.	N.R.	N.R.	Mod.	Low	Mod.
63	Truro River Wetland in Truro, MA	220	60		130				30		N.R.	N.R.	Mod.	High	Low	Mod.
64	Herring River Wetland in Truro & Wellfleet, MA	350	170		10				170		N.R.	N.R.	Mod.	High	Mod.	Mod.
65	Duck Harbor Wetland in Wellfleet, MA	400	170		80				150		N.R.	N.R.	Mod.	High	High	Mod.
66	Namskaket Creek Wetland in Brewster & Orleans, MA	35			20	5				10	Mod.	N.R.	N.R.	Mod.	Low	Mod.
67	Chathamport Wetland in Chatham, MA	50			35		5		10		N.R.	N.R.	Low	Mod.	Low	Mod.
68	Grass Pond Wetland in Harwich, MA	90	5		15	15			55		N.R.	Low	N.R.	Mod.	Low	Low
69	Wetland between Othrop Rd. & Sisson Rd. in Harwich	80		15	15				10	40	High	N.R.	N.R.	Mod.	Low	Mod.
70	Swan Pond River Wetland in Dennis, MA	140			40				30	70	High	N.R.	Mod.	Mod.	Low	Low
71	Ware Creek Wetland in Dennis, MA	80			30				25	55	Mod.	N.R.	N.R.	Low	Low	Low
72	Parkers River Wetland in Yarmouth, MA	80			30				30	20	Mod.	N.R.	Mod.	Mod.	Low	Low
73	Whitcomb Swamp in Mashpee, MA	55			25					30	Mod.	Low	Mod.	Mod.	Low	Mod.
74	Sagamore Beach Wetland in Sandwich & Bourne, MA	230							170	60	Low	N.R.	N.R.	Low	Low	Low
75	Savam Swamp in Nantucket, MA	90							30	60	Mod.	N.R.	N.R.	Low	Low	Low
76	Wetland near Polpis Section of Nantucket, MA	80			10	10	5		35	20	Mod.	N.R.	Mod.	Mod.	Low	Mod.
77	Phillips Run Swamp in Nantucket, MA	60	40							20	Low	N.R.	N.R.	Low	Low	Mod.
78	Head of Hummock Wetland in Nantucket, MA	60							45	15	Mod.	N.R.	Low	Mod.	Low	Mod.
79	Trots Swamp in Nantucket, MA	120			10				60	50	Mod.	N.R.	N.R.	Mod.	Low	Mod.
80	Long Pond Wetland in Nantucket, MA	100	10		30					60	Low	N.R.	Low	Mod.	Low	Mod.
81	Bentle Swamp in Edgartown, MA	16			2					14	Mod.	N.R.	N.R.	Mod.	Low	Mod.
82	Majors Cove Wetland in Oak Bluffs, MA	18			5				13		N.R.	N.R.	N.R.	Mod.	Low	High
83	Mill Brook Wetland in West Tisbury, MA	40	25					5		10	Mod.	N.R.	Mod.	Mod.	High	Mod.
84	Tiasquan River Wetland in Chilmark, MA	32							6	26	High	Low	N.R.	Mod.	Low	Mod.
85	Lobsterville Wetland in Gay Head, MA	39							22	17	N.R.	N.R.	N.R.	Mod.	Low	Mod.

Fig 5.13

Evaluated Wetlands

areas. Many towns in the region have acquired wetlands as conservation areas. In other instances, state forests, parks, and wildlife areas encompass wetlands. Zoning bylaws can also be a major determinant of the future of a wetland. A wetland area zoned for industrial development is in much more danger than an area zoned as flood plain land or that in a conservancy zone.

Public ownership information has been obtained for the wetlands of the region. Public ownership and zoning data have also been obtained for the 85-wetlands evaluated for various purposes. Wetland ownership and zoning data are presented in Tables 5.17 and 5.18.

Some interesting conclusions can be drawn from the ownership and zoning data. Public or quasi-public ownership of the evaluated wetlands is about twice as high as for all wetlands. This is probably because the evaluated wetlands are some of the largest wetland areas and so are very visible to the public and government. Many of the large evaluated wetlands are known far beyond their local area. Thus, it is conceivable that wetland acquisition naturally starts with the larger, better known areas. The larger areas are also better candidates for state agency acquisition, since they offer more management possibilities than the smaller areas. This acquisition of the large wetlands has been a pleasant circumstance since, in many cases, the larger areas are more diversified and offer more varied wildlife habitat.

Also interesting is the fact that Cape Cod and the Islands, with the lowest percentage of wetlands under protective zoning, have the highest percentage of publicly owned wetlands. It appears that much of the credit for protecting

TABLE 5.17 - EVALUATED WETLANDS SUMMARY

Subregion	Area of Evaluated Wetlands (Acres)	Percent Subregion Wetlands	Area in Public or Quasi-Public Ownership (Acres)	Area in Conservancy Zones (Acres)	(Percent) (Percent)	Total Publicly Owned or in Conservancy Zones (Acres)	(Percent) (Percent)
Northeast	12,038	27.2	3,974	4,997	41.5	8,971	74.5
Southeast	25,488	24.6	7,133	3,902	15.3	11,035	43.3
Cape Cod & Islands	3,075	26.6	1,484	306	10.0	1,790	58.2
Total	40,601	25.5	12,571	9,205	22.7	21,796	53.7

TABLE 5.18 - OWNERSHIP, RESTRICTIONS^{1/}, AND PROTECTIVE ZONING^{2/} OF INLAND WETLANDS

Subregion	Total Area Inland Wetlands (Acres)	Public & Quasi- public Ownership (Acres)	Percent of Total ^{5/}	Inland Wetland Restrictions ^{3/} (Acres)	Percent of Total ^{5/}	Protective Zoning ^{4/} (Acres)	Percent of Total ^{5/}	Total Public Owner- ship Protective Zoning & Wetlands Restrictions (Acres)	Percent of Total ^{5/}
Northeast	44,270	6,470	14.6	1,870	4.2	13,760	31.1	22,100	49.9
Southeast	103,660	13,150	12.7	--	--	29,530	28.5	42,680	41.2
Cape Cod & Islands	11,580	3,120	26.9	480	4.2	2,690	23.2	6,290	54.3
Total	159,510	22,740	14.3	2,350	1.5	45,980	28.8	71,070	44.6

1/ Massachusetts General Laws, Chapter 131, Section 40A.

2/ Municipal flood plain conservancy, watershed protection or similar zoning which restricts development activity in wetlands.

3/ Publicly or Quasi-publicly owned wetlands have been subtracted from these figures.

4/ Publicly or Quasi-publicly owned and inland wetland restriction totals have been subtracted from these figures.

5/ Total area of subregion inland wetlands.

wetland areas in this part of the region is due to the acquisition program of the National Park Service in conjunction with the Cape Cod National Sea Shore. The Martha's Vineyard Commission has a unique set of regulations for protecting coastal wetlands and wetlands bordering streams draining into Great Ponds. Acquisitions by the Sherriff's Meadow Foundation and Nantucket Conservation Foundation are an important part of the protection of wetlands on the Islands.

5.6 WATER QUALITY

In 1975, according to the SENE study, "two-thirds of major stream miles in the SENE region were below state standards, as were most waters in urban harbors." The SENE study also forecast that "by 1977, most of these waters--except those bearing the heaviest pollution burdens--will be fishable, and many will be swimmable." This tremendous progress in meeting water quality standards was, of course, due to the vast expenditures by the public and private sector for advanced wastewater treatment facilities.

Nearly 75 percent of the region's population is served by municipal sewerage systems, with the remaining 25 percent relying on individual septic systems. Pollution of rivers and harbors is especially bad, close to the urban areas of the region. Industrial wastes, combined sanitary-storm sewers and poorly treated municipal waste treatment discharges are the major water pollution problems. Table 5.19 gives a good picture of the relative magnitude of the water quality situation in various subbasins of the Coastal Region.

TABLE 5-4 KEY DETERMINANTS OF WATER QUALITY BY PLANNING AREA

PLANNING AREA	Determinants of Water Quality									Overall Severity Relevative Severity of Water Quality Problem All discharges, combined for the Planning Area as a whole.
	Combined Sewers/Urban Runoff	Municipal Discharges	Industrial Discharges	Low Streamflow	Septic Systems	Agricultural Runoff	Landfill Leachate	Oil Pollution	Watercraft Wastes	
Ipswich - North Shore	•	○	•	○	●		○	•	•	○
Boston Metropolitan	●	●	●	•			○	●	•	●
South Shore		○	•	○	○	•			•	○
Cape Cod & Islands		○			●	•			○	•
Buzzards Bay	●	●	○		•	○			•	○
Taunton	○	●	●	○	○	○		•		●
Blackstone & Vicinity	●	●	●	•	•		○	○		●
Narragansett Bay	●	○	•					○	○	○
SENE as a whole	●	●	●	○	○	•	•	•	•	●

● = Major determinant

○ = Intermediate determinant

• = Minor determinant

- On a regionwide basis, SENE found the six major sources of water pollution, in order of decreasing significance, to be: 1. combined sewer overflows and urban stormwater runoff; 2. municipal discharge; 3. industrial discharges; 4. nonpoint pollution sources; 5. oil pollution; and 6. watercraft wastes.

Sources of water pollution are normally placed into two major categories: point or nonpoint sources.

Point sources are those where a large quantity of pollutants is discharged into a stream from a discrete, readily identifiable source. The most common examples of point sources include discharges from wastewater treatment plants and industrial plants.

Nonpoint sources are more difficult to isolate. They usually involve relatively small quantities of pollutants which are discharged over relatively large areas. Examples of nonpoint sources include salt runoff from highways, animal wastes from agricultural enterprises, sediment from accelerated erosion problem areas, fertilizer and pesticide runoff from agricultural use, effluent from inadequate septic systems, and leachate from poorly situated or managed landfills or dumps.

Section 208 of Public Law 92-500, the Water Pollution Control Act, Amendments of 1972, authorized the preparation of Water Quality Management Plans for designated areas of the country. In the Coastal Region, most of the towns are within a designated "Areawide Waste Treatment Management Area." See Figure 5.14 for the location of these areas.

Major objectives of most of these "208" studies will be to assess the effectiveness of the installed or planned treatment of point pollution sources and the evaluation of the magnitude and seriousness of the nonpoint problem.

Merr
V31

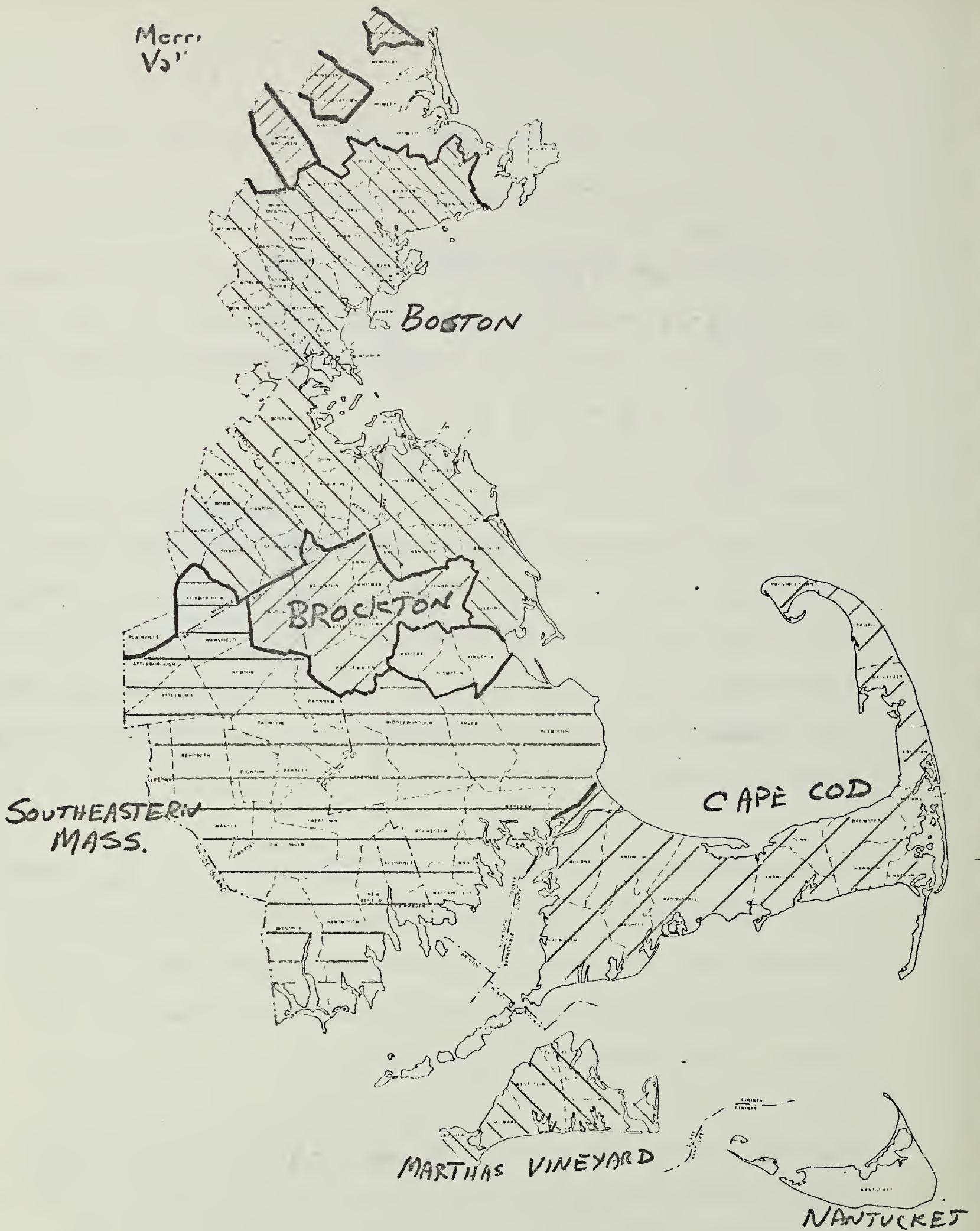


FIGURE 5.14
DESIGNATED AREA-WIDE WASTE TREATMENT
MANAGEMENT AREAS

Tentative solutions to water quality problems will also be formulated.

Studies in other parts of the United States have shown that nonpoint sources may produce half of the pollution observed. The "208" studies will attempt to determine how true this is for the Coastal Region.

Sewer service is provided to the areas indicated on Figure 5.15. Individual subsurface sewage disposal systems are relied on exclusively by the other areas. Even in towns with some municipal sewer service, residents in outlying areas must make use of individual septic tank-leach field systems.

In most cases, an adequately designed individual disposal system is able to treat and dispose of domestic sewage with little adverse effect on the groundwater. Unfortunately, many of the older systems in the region are inadequately designed. Also, septic systems usually do not remove significant amounts of nutrients, such as phosphates and nitrates. An additional problem can be the adequate disposal of sludge from septic tank cleanouts.

In addition, soil conditions in much of the area are unsuitable for septic tank systems. Seasonally high water table, bedrock or hardpan, and low soil permeability are the most common limitations on the use of individual disposal systems. Table 5-20 indicates results extracted from detailed soil surveys in 54 of the region's towns. A large percentage of the developable land in these towns has "severe" limitations for onsite septic tank disposal systems.



FIGURE 5.15
SEWER SERVICE AREAS

TABLE 5.20 - LIMITATIONS FOR ONSITE SEPTIC TANK DISPOSAL SYSTEMS^{1/}

City/Town	Town Area	Area Mapped	Limitations for Septic Tanks			Percent of Mapped Area with Severe Limitation
			Slight	Moderate	Severe	
			- - - - ACRES - - - -			
Taunton River Basin						
Bridgewater	10,183	16,864	3,826	1,580	11,458	68
Dighton	14,252	13,876	765	1,022	12,089	87
East Bridgewater	11,079	11,123	2,077	657	8,389	75
Easton	18,412	18,083	3,525	3,247	11,311	63
Foxborough	13,032	12,896	1,960	1,145	9,791	76
Halifax	11,069	9,929	2,746	1,033	6,150	62
Hanson	9,971	9,495	2,114	985	6,396	67
Lakeville	22,892	18,984	4,757	3,533	10,694	56
Mansfield	12,942	12,436	3,721	2,376	6,339	51
Middleborough	46,418	44,747	10,813	6,178	27,756	62
Norton	18,571	17,523	5,439	1,747	10,337	59
Plympton	9,632	9,286	1,712	1,226	6,348	68
Taunton	29,586	25,496	1,718	8,717	15,061	59
West Bridgewater	9,893	9,896	1,548	263	8,085	82
Ten Mile Basin						
North Attleborough	12,586	10,348	1,416	1,035	7,897	76
Seekonk	12,089	10,516	2,665	700	7,151	68
Cape Cod						
Barnstable	40,984	38,001	19,952	5,915	12,134	32
Brewster	18,976	13,023	4,800	3,204	4,919	38
Falmouth	31,504	23,316	11,642	3,749	7,925	34
Orleans	14,007	7,025	3,294	1,302	2,429	35
Yarmouth	16,448	15,892	10,546	1,873	3,473	22
South Shore Coastal Area						
Braintree	9,100	8,035	353	16	7,666	95
Cohasset	6,412	6,093	30	14	6,049	99
Duxbury	15,454	14,997	6,040	3,646	5,311	35
Hingham	14,501	12,848	2,156	930	9,762	76
Holbrook	4,769	4,029	507	798	2,724	68
Marshfield	18,678	17,221	3,129	2,888	11,204	65
Norwell	13,133	13,480	2,211	728	10,541	78
Pembroke	15,284	13,689	3,594	2,850	7,245	53
Plymouth	62,915	62,433	12,274	9,765	40,394	65
Randolph	6,569	5,332	946	1,768	2,618	49
Rockland	6,421	5,091	749	769	3,573	70
Scituate	11,281	10,201	596	109	9,496	93
Buzzards Bay Area						
Carver	27,504	23,001	8,538	5,076	9,387	41
Marion	9,105	9,089	909	3,343	4,837	53
Mattapoisett	11,136	11,019	740	2,844	7,435	67
Wareham	23,745	22,872	9,949	5,669	7,254	32
Ipswich-North Shore Basin						
Oxford	15,759	13,947	1,927	2,599	9,421	68
Groveland	6,080	5,400	470	430	4,500	83
Ipswich	23,204	13,986	1,877	1,368	10,741	77
Manchester	4,984	4,618	211	30	4,377	95
Newbury	16,224	10,009	485	575	8,949	89
Newburyport	6,616	4,844	1,374	193	3,277	68
North Andover	17,852	16,277	756	2,025	13,496	83
Rowley	12,767	9,249	1,411	1,036	6,802	74
Topsfield	8,188	7,853	1,181	1,112	5,560	71
North Reading	8,680	7,910	925	2,214	4,771	60
Neponset Basin						
Canton	12,460	10,310	1,623	1,264	7,423	72
Sharon	15,432	15,121	2,632	784	11,705	77
Stoughton	10,492	9,799	2,579	1,866	5,354	55
Walpole	13,330	12,623	1,984	1,841	8,798	70
Westwood	7,118	6,269	383	896	4,990	80
Narragansett Bay Area						
Rehoboth	30,493	30,078	3,902	5,285	20,891	69
Swansea	14,595	13,198	1,396	570	11,232	85

Agriculture-related pollution can result from two main sources: animal wastes and runoff containing residues of fertilizer, pesticides, and herbicides. In the Coastal Region, cattle, hogs, and chickens represent the largest potential source of animal waste pollution. In 1974, there were over 25,800 cattle, 18,800 hogs, and 400,000 chickens in the region. Nearly half of this livestock was located in Bristol County.

Unless properly managed, animal wastes present a water quality hazard. Because of the size of farms in the area and their location in relation to watercourses, animal waste is not a dominant pollution source in the region. However, according to the SENE study, agricultural runoff was considered to be an intermediate determinant of water quality in Bristol County. Proper manure storage and disposal techniques are expected to control the pollution hazard in the future.

Heavy use of commercial fertilizer is another agriculture-related nonpoint source of pollution. Fertilizer which is not utilized by crops can become a potential hazard, if washed into waterways, ponds, or lakes. In 1974, nearly 5,600 tons of commercial fertilizer were used on the farms in the region. Almost half of this fertilizer was used on pasture, hayland, or cornfields. The high cost of fertilizer and the relatively low-value crops tend to minimize fertilizer as a significant pollution source. Once again, Bristol County accounted for nearly half of the commercial fertilizer used in the region. Significant tonnages of fertilizer was also used in Essex and Plymouth Counties.

Pesticides and herbicides represent another potential agricultural pollution source. In 1974, farm operators spent over \$700,000 for sprays, dusts, and

fumigants to control insects and diseases in crops and pastures. Over half of the dollar value for pesticides and herbicides was expended in Plymouth County, most likely by cranberry growers. In view of the close proximity of cranberry bogs and watercourses, a high potential exists for water pollution from pesticides and herbicides.

The use of pesticides and herbicides in agriculture is not expected to be a significant pollution source in the noncranberry growing portions of the region. Pesticide use is regulated by the Pesticides Board, Massachusetts Department of Environmental Quality Engineering. The Extension Service has sponsored training sessions for growers to promote safe pesticide handling practices.

Forest management activities can also cause nonpoint pollution problems. This is true where recreation, improper grazing and poor road and trail layout and construction occur. Certain water quality parameters, including water temperature, turbidity, total dissolved solids, nitrate-nitrogen and fecal coliforms, may all be affected by the manner in which the watershed is managed. The severity is dependent on the particular management activities and the percentage of the watershed affected by the activities. Through proper planning, the effects of land management on water quality can be minimized.

5.7 WATER SUPPLY AND IRRIGATION

A. Water Supply

Communities in the Coastal Region meet their municipal water supply needs through ground water, surface supplies, and purchases from the Metropolitan District Commission (MDC) system. The present mix of water supply options being utilized and safe yields are shown in Table 5.21.

The area immediately north of Boston is almost exclusively served by the MDC. The northernmost part of the region relies heavily on ground water, while the interface communities rely on a combination of sources with Peabody and Wakefield drawing their supply from all three. The towns immediately south of Boston obtain their supplies from the MDC, ground water, or a combination of the two. Further south, communities obtain their water from ground water and surface sources. The vast majority of communities in Plymouth and Bristol Counties rely on ground water. Notable exceptions are the southern tier, including Somerset, Fall River, New Bedford, Taunton, Wareham, and Plymouth, which utilize surface sources exclusively or in conjunction with ground water. The water supply for Cape Cod and the Islands is almost exclusively from ground water.

B. Irrigation

Irrigation of agricultural crops utilizes about 14,000 acre-feet of water per year. The major use of irrigation is in the production of cranberries,

TABLE 5.21 - EXISTING MUNICIPAL WATER SUPPLY
NORTHEAST SECTION

Municipality	Safe Yield ^{1/} (mgd)	Ground- water	Surface Reser- voirs	MDC	Source or Supplier ^{2/}	Municipality	Safe Yield ^{1/} (mgd)	Ground- water	Surface Reser- voirs	MDC	Source or Supplier ^{2/}
Beverly/Salem	11.4		x			Newburyport	2.0	x	x		
Boston	141.7			x		North Andover	3.0		x		
Boxford private supplies		x				North Reading	1.3	x			
Canton	4.0	x		x		Norwood	7.5	x			
Chelsea	3.6			x		Peabody	10.2	x	x	x	
Danvers/Middleton	7.8	x	x			Reading	5.9	x			
Essex	1.5	x				Revere	3.9			x	
Everett	8.0			x		Rockport	0.8	x	x		
Georgetown	1.3	x				Rowley	0.9	x			
Gloucester	4.3		x			Salem	see Beverly		x		
Groveland	1.0	x				Saugus	2.9			x	
Hamilton	1.9	x				Sharon	1.7	x			
Ipswich	2.2	x	x			Stoneham	3.4			x	
Lynn	17.0		x			Swampscott	1.6			x	
Lynnfield	1.7	x		x		Topsfield	0.8	x			
Malden	6.9			x		Wakefield	5.2	x	x	x	
Manchester	2.3	x	x			Walpole	3.8	x			
Marblehead	2.2			x		Wenham	1.4	x			
Medford	8.1			x		Westwood	9.3 ^{3/}	x			
Melrose	3.0			x		Wilmington	7.1	x			
Middleton	see Danvers	x	x			Winchester	2.9	x		x	
Milton	2.5			x		Winthrop	1.8			x	
Nahant	0.6			x		Woburn	13.2	x	x		
Newbury	0.22 ^{1/}	x	x								
SOUTHEAST SECTION											
Abington/Rockland	7.8	x	x			Marshfield	5.8	x			
Acushnet	.4		x			Mattapoisett	2.1	x			
Attleboro	13.8	x	x			Middleborough	1.8	x			
Avon	.6	x				New Bedford	20.0		x		
Berkley private supplies		x				N. Attleborough	4.5	x			
Braintree	5.9	x	x			Norton	2.1	x			
Bridgewater	2.5	x				Norwell	1.9	x			
Brockton	13.4		x			Pembroke	1.8	x	x		
Carver private supplies		x				Plainville	1.2	x			
Cohasset	1.2	x	x			Plymouth	5.5	x	x		
Dartmouth	2.5	x	x			Plympton private supplies		x			
Dighton	.7	x	x			Quincy	10.2			x	
Duxbury	2.8	x				Randolph/Holbrook	7.6	x	x		
E. Bridgewater	1.8	x				Raynham	0.8	x			
Easton	2.7	x				Rehoboth private supplies		x			
Fairhaven	2.5	x	x			Rochester private supplies		x			
Fall River	21.5		x			Rockland	see Abington	x	x		
Foxborough	3.9	x				Scituate	4.4	x	x		
Freetown	1.3	x	x			Seekonk	3.4	x			
Halifax	0.9	x				Somerset	5.3	x	x		
Hanover	3.4	x				Stoughton	2.6	x			
Hanson	0.5		x			Swansea	2.8	x			
Hingham/Hull	7.0	x				Taunton	9.5		x		
Holbrook	see Randolph	x	x			Wareham	4.5	x	x		
Hull	see Hingham	x				W. Bridgewater	1.92 ^{1/}	x			
Kingston	2.9	x				Westport	0.04	x			
Lakeville	0.3	x				Weymouth	13.7	x	x		
Mansfield	1.6	x				Whitman	0.7		x		
Marion	1.4	x									
CAPE COD AND ISLANDS SECTION											
Barnstable	12.2	x				Truro	see Provincetown	x			
Bourne	5.9	x				Wellfleet private supplies		x			
Brewster	2.8	x				Yarmouth	6.9	x			
Chatham	3.5	x				Chilmark	0.05	x			
Dennis	6.1	x				Edgartown	5.2	x			
Eastham private supplies		x				Gay Head private supplies		x			
Falmouth	14.1	x	x			Gosnold	.15	x			
Harwich	7.2	x				Nantucket	3.7	x			
Mashpee	1.7	x				Oak Bluffs	1.3	x			
Orleans	2.1	x				Tisbury	5.0	x			
Provincetown	3.0	x				West Tisbury private supplies		x			
Sandwich	1.6	x									

1/ Interim Report, Water Supply Policy Study, Executive Office of Environmental Affairs, October 1976.

2/ Report of the Southeastern New England Study, New England River Basins Commission, December 1975.

3/ Safe Yield of the Dedham Water Company which supplies Westwood.

which is estimated to require nearly 13,000 acre-feet annually. The remaining 1,000 acre-feet is used primarily to irrigate high value nursery stock. Because of the over 42 inches of rainfall which the region receives, most other crops do not require irrigation for successful production. Agricultural irrigation data is presented in Table 5.22 for the counties comprising the Coastal Region.

TABLE 5.22 - IRRIGATED CROPLAND

County	Area Irrigated (acres)	Water Used (acre-feet)	Average Use (inches-acre)
Barnstable	892	697	9.4
Bristol	1,581	1,138	8.6
Dukes	48	25	6.2
Essex	1,162	818	8.4
Middlesex	1,576	1,049	8.0
Norfolk	351	236	8.1
Plymouth	8,930	9,963	13.4

The irrigation water figures in Table 5.22 only reflect water used during the growing season to provide moisture needed for plant growth. Cranberry growers also utilize a great deal of water throughout the year for frost protection, winter freeze protection, and harvesting. These water uses far exceed the irrigation requirements. Total water application usually exceeds 105 inches per year. The 10,900-acres of producing cranberry bogs utilize in excess of 95,000 acre-feet of water per year.

Lack of water for agricultural irrigation is not a problem in the region. Cranberry bog operators have removed many bogs from production, retaining those which had sufficient resources to raise the crop. In some instances,

bogs have water shortages at certain periods of the year, which could be alleviated by better water management techniques. Operators are increasingly shifting to sprinkler irrigation systems to replace the older method of bogflooding. Sprinkler irrigation requires a much lower volume of water than flooding. Another recent development has been the introduction of waterharvesting of berries which, although it uses water as opposed to the conventional cranberry rakes, results in a much higher percentage of the crop being harvested.

All in all, irrigation is not a problem area. The ongoing program of the Soil Conservation Service is assisting growers to install sprinkler irrigation systems, water-control structures, and other water management features. As a result, the topic of irrigation will not receive further consideration in this report.

5.8 FISH AND WILDLIFE

The Massachusetts Division of Fisheries and Wildlife manages fish and wildlife for their ecological, recreational, scientific, educational, and commercial values. These resources thus have importance for Massachusetts far beyond their intrinsic values and involve millions of people who are associated in one way or another with fish and wildlife. These numbers include the 3/4 million licensed and unlicensed hunters, fishermen, and trappers who depend directly upon the renewable animal resources of the state, as well as the thousands of others who are bait dealers, gun and tackle manufacturers,

sporting goods distributors and retailers, fur buyers, licensing agents, law enforcement personnel, boat liverymen, gasoline station proprietors, and operators of tourist accommodations. A recent study showed that fish and wildlife-generated business was worth \$110 million annually to the Bay State.

5.81 Fish

A. Introduction

The discussion of fishery resources in the Coastal Region will be confined to fresh water and the important fish species which utilize fresh water during their life cycle. Anadromous fish species (which move from salt water to fresh water to spawn) are among the outstanding fishery resources described in Section 5.81C.

In the Coastal Region, fish and fishing are sufficiently important that 60,000 licensees and perhaps another 100,000 unlicensed youngsters annually pursue recreational angling.

Table 5.23 provides summary information on the freshwater ponds, lakes, and reservoirs in the Coastal Region which are over 20 acres in size. Both cold water and warm water fisheries are available, and the total acreage of those water bodies is 44,787. Cape Cod and the Islands provide by far the greatest acreage of cold water fishery in the region.

Table 5.24 summarizes information on the stream fisheries, providing mileages of cold water and warm water types in various parts of the region. Totals indicate approximately 408 miles of cold water fishery and approximately 142 miles of warm water fishery.

Access to the rivers, streams, ponds, lakes, and reservoirs varies from none, to locally-improved access, to full public access.

The Public Access Board, under the Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles, uses a small portion of income from the state gasoline tax to acquire public access to great ponds and other waters in the state, and for trails for snowmobiling, hiking, and skiing. At its water access points, the board constructs launching ramps, canoe or small boat landings, parking areas, and approach roads.

The Public Access Board will continue to develop facilities throughout the state. The board's program concentrates on larger, more popular areas, so that greater numbers of people will benefit.

The Public Access Board has acquired access to waters in the coastal section of Massachusetts, shown in Table 5.25.

TABLE 5.23 - SUMMARY OF INVENTORY OF PONDS, LAKES AND RESERVOIRS
20 ACRES AND OVER IN SIZE^{1/}

Item	Unit	Subregion			Totals
		North- east	South- east	Cape Cod & Islands	
Total Number of Ponds, etc.		88	220	122	430
Total Area	Ac	7,146	26,767	10,874	44,787
Cold Water Fisheries-Number		9	9	26	44
Cold Water Fisheries-Area	Ac	692	859	2,771	4,322
Warm Water Fisheries-Number		79	211	96	386
Warm Water Fisheries-Area	Ac	6,465	25,908	8,103	40,465

^{1/} Major Data Source: Inventory of the Ponds, Lakes and Reservoirs of various counties by James A. McCann et al, Water Resources Research Center, University of Massachusetts, Amherst, Massachusetts, 1972.

^{2/} See Appendix C for information concerning public water bodies.

TABLE 5.24 - SUMMARY OF STREAM FISHERIES^{1/}

Subregion	Principal Fisheries Type		Remarks
	Cold Water (miles)	Warm Water (miles)	
<u>Northeast</u>			
Ipswich - North Shore	133.2	2.2	
Mystic - Neponset	33.3	23.	
Subtotal - NE	166.5	25.2	
<u>Southeast</u>			
South Shore	62.	10.8	Coho salmon introduction program in Indian Head River.
Buzzards Bay	31.1	22.5	Mattapoisett River - best trout stream in study area.
Narragansett Bay	20.5	--	Palmer River - best trout stream in study area.
Taunton	91.3	83.8	Wading, Canoe and Winnetuxet Rivers - best trout streams in study area.
Subtotal - SE	204.9	117.1	
<u>Cape Cod & Islands</u>	36.4	—	"Salter" trout (sea run trout); Mashpee River and Scorton Creek - best trout streams in study area.
Total - Coastal Region	407.8	142.3	

^{1/} Data Source: SENE Study, Fish and Wildlife Single Purpose Reports, prepared by U.S. Fish and Wildlife Service, 1973-1974.

B. Outstanding Fishery Resources

Anadromous Fishery

Important anadromous fish in the sport and commercial fisheries of Massachusetts are the alewife (herring), the American shad, and the rainbow smelt.

The alewife is the most abundant anadromous fish in the state. Millions ascend coastal rivers and streams each spring to spawn in freshwater ponds and lakes. The adult fish return to salt water after spawning, and the young migrate to sea by autumn. Alewives, primarily plankton feeders, are valuable as forage for larger predatory fish. Alewives taken from the ocean are used in fish meal and for bait; fish netted on their spawning runs in fresh water are used for bait and for food.

The American shad is the largest member of the herring family. Coastal Region, only the North River in Scituate and the Palmer River in Rehoboth have substantial runs. Most adults return to sea after spawning; the young migrate to sea by fall. Shad feed mostly on plankton and are themselves prized as game fish.

Rainbow smelt are found along the entire coast of Massachusetts, where they travel a short distance up fresh water streams to spawn

TABLE 5.25 - ACCESS ACQUIRED BY PUBLIC ACCESS BOARD

Water Body	Location	Area (acres)
Northeast:		
Boston Harbor	Lynn	TW ^{1/}
Boston Harbor	Winthrop	TW
Cheacco Lake	Hamilton	209
Danvers River	Salem	
Hood Pond	Ipswich	67
Horn Pond	Woburn	102
Ipswich River	Ipswich	TW
Little Mystic Channel	Boston	TW
Porter River	Danvers	TW
Rock Pond	Georgetown	57
Southeast:		
Back River	Weymouth	TW
Coles River	Swansea	TW
Falls Pond	North Attleborough	156
Lake Nippenicket	Bridgewater	354
Long Pond	Freetown	1721
Mattapoissett Bay	Mattapoissett	TW
Nasketucket Bay	Fairhaven	TW
New Bedford Harbor (Pease Park)	Fairhaven	TW
Sabbatia Lake	Taunton	237
South Watuppa Pond	Fall River	1283
Westport River	Westport	TW
Weweantic River	Wareham	TW
Apponagansett River	Dartmouth	TW
Green Harbor	Marshfield	TW
Long Pond	Plymouth	215
Little Long Pond	Plymouth	45
Cape Cod and Islands:		
Lagoon Pond (access to Vineyard Sound)	Tisbury	TW
Peters Pond	Sandwich	127
Scituate Harbor (Jericho Road)	Scituate	TW
Pamet River (access to Cape Cod Bay)	Truro	TW
Bass River (access to Nantucket Sound)	Yarmouth	TW
Lovells Pond	Barnstable	54
Shubael Pond	Barnstable	56
Cliff Pond	Brewster	193
Little Cliff Pond	Brewster	33
Sheep Pond	Brewster	142
Sesuit Harbor	Dennis	TW
Rock Harbor	Eastham	TW
Katama Point	Edgartown	TW
Ashumet Pond	Falmouth	203
Green Pond	Falmouth	TW
Saquatucket Harbor	Harwich	TW
Johns Pond	Maspee	317
Maspee-Wakeby Ponds	Maspee	729

^{1/} Tidewater.

between March and mid-May. Smelt are caught with hook and line, mostly during fall and winter.

Major anadromous fish runs in the Coastal Region are, as follows:

Northeastern Section

Parker River - alewives

Southeastern Section

Back River, Weymouth - alewives

North River - alewives, shad

Jones River, Kingston - alewives, smelt

Town Brook, Plymouth - alewives, smelt

Agawam River, Wareham - alewives, smelt

Nemasket River, Middleborough - alewives

Palmer River, Rehoboth - shad

Cape Cod and Islands Section

Herring River, Bourne - alewives

Stony Brook, Brewster - alewives

The Division of Marine Fisheries exercises responsibility for approximately 100 anadromous fish runs in coastal rivers and streams. Fishways are constructed and maintained to pass upstream migrants around dams; and shad and smelt propagation are parts of the program.

North River - Experimental Coho Salmon Project

The North River in Plymouth County, together with its tributaries, supports runs of alewives and shad. A tributary, the Indianhead River, has been utilized since 1970 by the Division of Marine Fisheries for an experimental coho salmon project. Each spring, hatchery-reared smelts

are released to migrate to sea, and each fall, returning 3-year-old fish are collected to obtain eggs for hatchery rearing. There is a modest sport fishery for the coho.

"Salter" Trout

"Salter" is the term applied to a trout which becomes sea-run. Populations of brook trout may become sea-run during their second year of life and reenter fresh water periodically. Similarly, stocked brown trout in several Massachusetts coastal streams become sea-run. (The sea-run browns are the result of a Massachusetts Division of Fisheries and Wildlife (MDFW) program begun in 1973.) The browns grow faster and live longer than the brook trout. "Salter" trout are a potential trophy fish for sportsmen.

A 1973-1974 survey by MDFW established a list of 70 coastal streams believed to support sea-run trout. Based on that survey, four river systems were selected for intensive investigation because of their potential as habitat for sea-run trout: The Parker River in the northeast section; the Jones River in the southeast section; and on Cape Cod, Scorton Creek on the north shore and the southern Cape Cod system, a number of streams which flow into Nantucket Sound.

Nine streams are currently being stocked with sea-run brown trout.

These streams are the Parker River, the Jones River, Beaverdam Brook in the southeastern section, and on Cape Cod, the Coonamessett, Child's, Quashnet, and Mashpee Rivers, Santuit Creek, and Scorton Creek.

Trout Fishery in Ponds on Cape Cod

Outstanding trout fishing is provided in a number of cold-water ponds on Cape Cod. About one-third of the ponded waters over 40 acres in size are classified as cold-water fishery. Those 16 ponds total 2,555 acres; 14 of the ponds are currently stocked with trout. Cliff Pond in Brewster has a particularly outstanding cold-water fishery.

The water in the cold-water ponds is ground water exposed in kettle holes. The permeable sandy soils allow free circulation of water into and out of the ponds and that, in conjunction with the Cape's maritime climate, allows the water temperature to remain cool enough for trout throughout the summer. Other waters in the Coastal Region can support only put-and-take trout fisheries because the warm water temperatures in summer prevent carry-over from year to year.

Fishes Existing in Limited Numbers in Massachusetts Which Are Found in the Coastal Region

Eight species of fish found in the Coastal Region of Massachusetts are considered to exist in limited numbers in the state. Those fishes are shown in Table 5.26. Some species are more plentiful elsewhere.

TABLE 5.26 - FISHES EXISTING IN LIMITED NUMBERS IN MASSACHUSETTS
WHICH ARE FOUND IN THE COASTAL REGION

Species	Distribution	Status ^{1/}
Swamp darter	Eastern coastal lowland ponds and streams	Uc
Fourspine stickleback	Marine or brackish coastal waters; sometimes ascends streams	U
Ninespine stickleback	Marine or brackish coastal waters; sometimes ascends streams	U
Threespine stickleback	Marine or brackish coastal waters; sometimes ascends streams	U
Longear sunfish	Introduced; reported from Palmer River, Rehoboth	Uc
Atlantic sturgeon	Ascends coastal streams in spring to spawn; may occur in Merrimack River (also Connecticut River)	T
Shortnose sturgeon	Possibly in coastal brackish	T*
Walleye	Assawompset, Long (Lakeville), Quittacas, Little Quittacas, and Picksha Ponds, Nemasket River; non-reproducing relicts of past stocking - approximately 20 years ago	Uc

^{1/} Uc - Uncommon
U - Status undetermined
T - Threatened

* Listed in Threatened Wildlife of the United States, March 1973, United States Department of the Interior, Fish and Wildlife Service, Resource Publication 114, U.S. Government Printing Office, Washington, D.C.

SOURCE: "An Inventory of Massachusetts Fish and Wildlife (Vertebrate Resources)" by P. S. Mugford, Massachusetts Division of Fisheries and Wildlife, Boston, Massachusetts, 1975.

5.82 WILDLIFE

A. Introduction

Despite the density of population in eastern Massachusetts, the Coastal Region provides habitat for a wide and interesting variety of wildlife species. The number of different ecological niches available for them to fill is related to the geographic location of the region and the physiographic variation within it. Ecosystem types range from upland forest to sand beach.

The greatest value of the wildlife species in the region, like those anywhere, is their continuing to exist and fulfill their roles in the natural scheme of things of which we, too, are a part.

Where different species occur in the region is determined in large part by the use to which the land is put and by the resulting vegetative cover. Tables in Section 5.82C show acreages for various land uses and cover types in the Coastal Region and plant animal species which are associated. Trends in land use in the region emphasize the importance of efforts to retain or improve what valuable wildlife habitat remains.

Some of the outstanding wildlife resources in the region are described briefly in Section 5.82D. Birds are a particularly outstanding resource; many interesting and uncommon species nest in the region or rest there

during their migrations along the Atlantic flyway. Important wildlife areas, some publicly-owned and permanently preserved, others privately-owned and with questionable futures, provide habitat for both common and uncommon species. Protection of the habitats of those species so uncommon as to be designated "endangered" should receive high priority.

B. Value and Use of Wildlife Resources

The greatest value of wildlife species is that each species is a part of an ecosystem. Each has its role. Life depends on adequate functioning of the ecosystem, and knowledge of the interrelationships involved is still incomplete. Altering wildlife populations by habitat modification or by other means can have consequences which cannot be predicted.

The secondary value of wildlife resources is its recreational use by the human population. Wildlife is used in both consumptive and nonconsumptive ways.

Nonconsumptive

Nonconsumptive recreational uses of wildlife resources include bird watching, nature study, and wildlife photography. These pursuits are especially popular in the Coastal Region where there is substantial interest in nature and the preservation of natural areas, and because

there exist in the region outstanding locations for the observation of wildlife. Many have been permanently preserved as parks or refuges under governmental or private control.

Consumptive

Approximately 2.4 percent of the Massachusetts' population participates in hunting. A much smaller percentage engages in trapping. Harvestable wildlife species include white-tailed deer, snowshoe hare, cottontail rabbit, gray squirrel, opossum, raccoon, pheasant, bob-white, ruffed grouse, woodcock and waterfowl, all of which are hunted. In addition, the hunting, taking, or possession of house sparrow, starling, chipmunk, flying squirrel, and woodchuck is permitted when carried out lawfully. Beaver, muskrat, mink, weasel, otter, fox, raccoon, opossum, and bobcat may be trapped. Most of these species are found on Cape Cod, but there are no fox, bobcat, opossum, weasel, porcupine, or New England cottontail on either Martha's Vineyard or Nantucket. In addition, raccoon, muskrat, mink, otter, and skunk are absent from Nantucket.

The amount of hunting carried on in the Coastal Region is decreasing. In addition to declining habitat, population growth has caused many towns to prohibit or restrict hunting. (See Figure 5.16) Another strong factor involved has been the rise of anti-hunting sentiment. This is particularly strong in the Coastal Region.

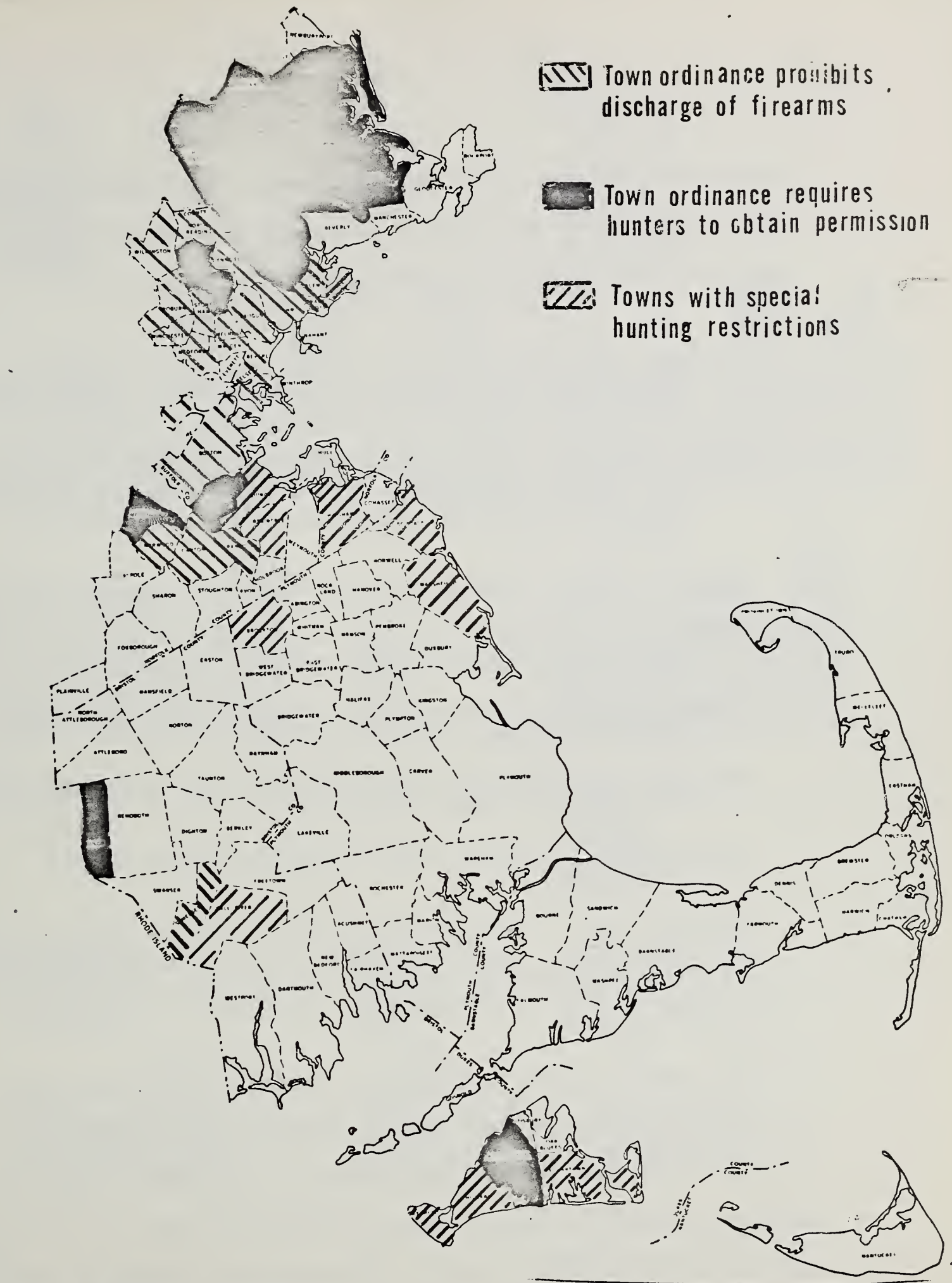


Fig 5.16
HUNTING LIMITATIONS

Nevertheless, hunting remains a popular sport. Statewide hunter preference for various game species, in descending order of importance, with notes on habitat and stocking, are, as follows:

Pheasant - agricultural land well interspersed with brushland, swamps, and small woodlots. Stocked annually to supplement wild population.

Deer - forested land in various stages of succession interspersed with swamps and openland. Deer are most numerous on Martha's Vineyard and Nantucket; over 100 are harvested from each island annually.

Ducks and Geese - coastal and inland wetlands, permanent open waters.

Ruffed Grouse - forest land in various stages of succession, well interspersed with old fields, orchards, and swamps.

Cottontail Rabbit - agricultural land well interspersed with brushland, swamps, and small woodlots.

Woodcock - woodland areas containing much alder and aspen and fairly clear of heavy ground cover.

Gray Squirrel - hardwood forest containing mature oak and hickory trees.

Bob-white Quail - agricultural land well interspersed with brushland, swamps, and small woodlots. Quail can be hunted only in southeastern Massachusetts, on the Cape, and on the Islands. Two wildlife management areas are stocked.

Snowshoe hare are released annually by the Division of Fisheries and Wildlife in both Bristol and Plymouth Counties to supplement native populations. Irregular releases have occurred in Barnstable, Dukes, and Nantucket Counties, and small numbers of hare are known to be present in Barnstable and Nantucket Counties; possibly also on Martha's Vineyard.

TABLE 5.27

LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Approximate % of Land in Region	Vegetation Associated with Cover Type			Wildlife Associated with Cover Type		
		Trees	Understory	Plants	Mammals	Birds	Reptiles, Amphibians
Hardwood	18	scrub oak black cherry white oak red maple sugar maple red oak white ash white birch black locust American beech basswood quaking aspen	arrowwood wild raisin spice bush green brier witch hazel sarsaparilla		whitetail deer eastern cottontail gray fox shorttail weasel opossum shorttail shrew hairy-tailed mole star-nosed mole raccoon eastern chipmunk gray squirrel striped skunk northern flying squirrel white-footed mouse woodland jumping mouse	ruffed grouse screech owl red-tailed hawk hairy woodpecker downy woodpecker yellow-bellied sapsucker blue jay common crow black-capped chickadee white breasted nuthatch red breasted nuthatch myrtle warbler scarlet tanager cardinal rufous-sided towhee slate-colored junco white-throated sparrow	spring peeper common garter snake northern black racer eastern milk snake American toad
Softwood	5	pitch pine white pine eastern hemlock other species often in plantations: scotch pine Norway spruce red pine white spruce	green brier honeysuckle		whitetail deer red squirrel	screech owl long-eared owl blue jay common crow black-capped chickadee slate-colored junco starling pine grosbeak	--
Mixed Hardwood and Softwood	21	scarlet oak black oak white pine eastern hemlock pitch pine American elm sugar maple red maple white ash American beech	arrowwood honeysuckle wild raisin spice bush green brier wild grape wintergreen shining clubmoss partridge- berry	sassafras witch hazel sarsaparilla salt spray rose	whitetail deer eastern cottontail gray fox raccoon striped skunk opossum shorttail shrew star-nosed mole hairy-tailed mole eastern chipmunk gray squirrel red squirrel northern flying squirrel white-footed mouse woodland jumping mouse	ruffed grouse long-eared owl red-tailed hawk yellow-bellied sapsucker hairy woodpecker downy woodpecker blue jay common crow black-capped chickadee white-breasted nuthatch red-breasted nuthatch myrtle warbler scarlet tanager rufous-sided towhee slate-colored junco white-throated sparrow northern oriole evening grosbeak	common garter snake northern black racer eastern milk snake American toad common newt spotted salamander

TABLE 5.27

LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Approximate % of Land in Region	Vegetation Associated with Cover Type		Wildlife Associated with Cover Type			
		Trees	Understory	Plants	Mammals	Birds	Reptiles, Amphibians
Hardwood	18	scrub oak black cherry white oak red maple sugar maple red oak white ash white birch black locust American beech basswood quaking aspen	arrowwood wild raisin spice bush green brier witch hazel sarsaparilla		whitetail deer eastern cottontail gray fox shorttail weasel oppossum shorttail shrew hairy-tailed mole star-nosed mole raccoon eastern chipmunk gray squirrel striped skunk northern flying squirrel white-footed mouse woodland jumping mouse	ruffed grouse screech owl red-tailed hawk hairy woodpecker downy woodpecker yellow-bellied sapsucker blue jay common crow black-capped chickadee white breasted nuthatch red breasted nuthatch myrtle warbler scarlet tanager cardinal rufous-sided towhee slate-colored junco white-throated sparrow	spring peeper common garter snake northern black racer eastern milk snake American toad
Softwood	5	pitch pine white pine eastern hemlock other species often in plantations: scotch pine Norway spruce red pine white spruce	green brier honeysuckle		whitetail deer red squirrel.	screech owl long-eared owl blue jay common crow black-capped chickadee slate-colored junco starling pine grosbeak	--
Mixed Hardwood and Softwood	21	scarlet oak black oak white pine eastern hemlock pitch pine American elm sugar maple red maple white ash American beech	arrowwood honeysuckle wild raisin spice bush green brier wild grape wintergreen shining clubmoss partridge-berry	sassafras witch hazel sarsaparilla salt spray rose	whitetail deer eastern cottontail gray fox raccoon striped skunk opossum shorttail shrew star-nosed mole hairy-tailed mole eastern chipmunk gray squirrel red squirrel northern flying squirrel white-footed mouse woodland jumping mouse	ruffed grouse long-eared owl red-tailed hawk yellow-bellied sapsucker hairy woodpecker downy woodpecker blue jay common crow black-capped chickadee white-breasted nuthatch red-breasted nuthatch myrtle warbler scarlet tanager rufous-sided towhee slate-colored junco white-throated sparrow northern oriole evening grosbeak	common garter snake northern black racer eastern milk snake American toad common newt spotted salamander

TABLE 5.27 - cont.

LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Approximate % of Land in Region	Vegetation Associated with Cover Type			Wildlife Associated with Cover Type		
		Trees	Understory	Plants	Mammals	Birds	Reptiles, Amphibians
Wetland - Fresh Water	11	red maple black willow trembling aspen American elm	speckled alder grasses reeds sedges cattail silky dogwood witch hazel green brier	spice bush highbush blueberry arrowwood honeysuckle	muskrat mink raccoon star-nosed mole little brown myotis eastern pipistrel hoary bat otter beaver	woodcock tufted titmouse cabbird cedar waxwing brown thrasher great blue heron eastern green heron kingfisher green-winged teal mallard duck black duck wood duck tree swallow	snapping turtle stinkpot spotted turtle wood turtle eastern box turtle eastern painted turtle eastern ribbon snake spotted salamander northern black racer red-backed salamander American toad spring peeper bullfrog pickerel frog wood frog gray tree frog
Wetland - Salt Water	2	--	cordgrass - salt meadow and salt marsh spike grass salt marsh bulrush black grass ditch reed		muskrat red fox striped skunk	black duck mallard duck great blue heron black crowned night heron osprey marsh hawk	northern diamondback terrapin

TABLE 5.27 - cont.

LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Approximate % of Land in Region	Vegetation Associated with Cover Type			Wildlife Associated with Cover Type		
		Trees	Understory	Plants	Mammals	Birds	Reptiles, Amphibians
Wetland - Fresh Water	11	red maple black willow trembling aspen American elm	speckled alder grasses reeds sedges cattail silky dogwood witch hazel green brier	spice bush highbush blueberry arrowwood honeysuckle	muskrat mink raccoon star-nosed mole little brown myotis eastern pipistrel hoary bat otter beaver	woodcock tufted titmouse catbird cedar waxwing brown thrasher great blue heron eastern green heron kingfisher green-winged teal mallard duck black duck wood duck tree swallow	snapping turtle stinkpot spotted turtle wood turtle eastern box turtle eastern painted turtle eastern ribbon snake spotted salamander northern black racer red-backed salamander American toad spring peeper bullfrog pickerel frog wood frog gray tree frog
Wetland - Salt Water	2	--	cordgrass - salt meadow and salt marsh spike grass salt marsh bulrush black grass ditch reed		muskrat red fox striped skunk	black duck mallard duck great blue heron black crowned night heron osprey marsh hawk	northern diamondback terrapin

fresh meadows are used as feeding grounds and for some nesting with favorable conditions. Both types provide food for deer during summer and fall, year-round food for fox, skunk, weasel, raccoon, and food and cover for pheasant.

Plants found in wetlands in the region vary widely, depending on the depth of water, period of flooding, or stage of plant succession.

Nearly all types of land or land uses support or allow some wildlife species. The greater the habitat diversity, the greater the diversity of wildlife species. Edge between field, forest, and wetland, as along a field or powerline, is extremely valuable to wildlife because it provides food and cover in close proximity.

Along with diversity, the extent of habitat is important. An area which would be ideal for a certain species may be useless to that species because civilization has made inroads and destroyed the continuity of the environment.

Land uses and vegetative cover are not static. Changes occur naturally, as plant succession proceeds in areas not managed by man. An abandoned field gradually becomes a young forest while man-caused changes occur more rapidly.

fresh meadows are used as feeding grounds and for some nesting with favorable conditions. Both types provide food for deer during summer and fall, year-round food for fox, skunk, weasel, raccoon, and food and cover for pheasant.

Plants found in wetlands in the region vary widely, depending on the depth of water, period of flooding, or stage of plant succession.

Nearly all types of land or land uses support or allow some wildlife species. The greater the habitat diversity, the greater the diversity of wildlife species. Edge between field, forest, and wetland, as along a field or powerline, is extremely valuable to wildlife because it provides food and cover in close proximity.

Along with diversity, the extent of habitat is important. An area which would be ideal for a certain species may be useless to that species because civilization has made inroads and destroyed the continuity of the environment.

Land uses and vegetative cover are not static. Changes occur naturally, as plant succession proceeds in areas not managed by man. An abandoned field gradually becomes a young forest while man-caused changes occur more rapidly.

D. Outstanding Wildlife Resources

Waterfowl

The Coastal Region provides habitat to geese and ducks of many species, both residents and migrants. Of the marsh and pond ducks, the black duck and the mallard duck are common species; the former preferring salt water, the latter, fresh water. Both are Massachusetts' breeding birds. Some Canada geese also breed here and others use the wetlands and coastal waters during migration.

Many migrating species of waterfowl rest and feed in the Coastal Region because two eastern routes of the Atlantic flyway pass through in a north-south direction. Many species winter in the area, enabled to remain by the milder weather of the maritime climate. Species counted on the Massachusetts Division of Fisheries and Wildlife's annual winter inventory include (in order of decreasing numbers): eider, black duck, scaup, Canada Goose, goldeneye, scoter, bufflehead, merganser, and mallard. Thousands of eider are counted in Kingston and Duxbury Bays each winter. Wintering waterfowl number in the hundreds at many locations along the shore of the mainland and islands.

Colonial Waterbirds and Shore Birds

There are between 200 and 300 nesting colonies of waterbirds in the Coastal Region of Massachusetts. They are located mainly on the off-shore islands.

D. Outstanding Wildlife Resources

Waterfowl

The Coastal Region provides habitat to geese and ducks of many species, both residents and migrants. Of the marsh and pond ducks, the black duck and the mallard duck are common species; the former preferring salt water, the latter, fresh water. Both are Massachusetts' breeding birds. Some Canada geese also breed here and others use the wetlands and coastal waters during migration.

Many migrating species of waterfowl rest and feed in the Coastal Region because two eastern routes of the Atlantic flyway pass through in a north-south direction. Many species winter in the area, enabled to remain by the milder weather of the maritime climate. Species counted on the Massachusetts Division of Fisheries and Wildlife's annual winter inventory include (in order of decreasing numbers): eider, black duck, scaup, Canada Goose, goldeneye, scoter, bufflehead, merganser, and mallard. Thousands of eider are counted in Kingston and Duxbury Bays each winter. Wintering waterfowl number in the hundreds at many locations along the shore of the mainland and islands.

Colonial Waterbirds and Shore Birds

There are between 200 and 300 nesting colonies of waterbirds in the Coastal Region of Massachusetts. They are located mainly on the off-shore islands.

and feed during migration. The bird populations involved would suffer serious consequences if those sites should be lost to them. Important sites for stopping-over in the northeast are the Newburyport and Plum Islands area and Ipswich Beach; in the southeast, Snake Island in Boston Harbor, Third Cliff at Scituate, and the Plymouth Beach and Duxbury Beach area; on the Cape, the outer beaches from Monomoy to Eastham and marshes behind them all have large tidal flats attractive to shore birds.

TABLE 5.28 - COLONIAL WATERBIRDS OF THE MASSACHUSETTS COAST, 1976

Species	Approximate Number of Breeding Pairs	Status
Gulls		
Great black-backed	3,000	Relatively stable
Herring	30,000	Declining
Laughing	180	Continuing to decline
Terns		
Arctic	66	Continuing to decline*
Roseate	1,390	Continuing to decline*
Common	5,350	Declining*
Least	1,470	Stable
Double-crested cormorant	1,130	Increasing
Hérons		
Black-crowned night	1,500	Declining
Little blue	10	Probably stable
Louisiana	3	Recent invader
Egrets		
Great	6	Slightly increasing
Snowy	600	Rapidly increasing
Cattle	10	Increasing
Glossy Ibis	75	Recent invader

* Procedures for acquiring "endangered" designation are being initiated.

and feed during migration. The bird populations involved would suffer serious consequences if those sites should be lost to them. Important sites for stopping-over in the northeast are the Newburyport and Plum Islands area and Ipswich Beach; in the southeast, Snake Island in Boston Harbor, Third Cliff at Scituate, and the Plymouth Beach and Duxbury Beach area; on the Cape, the outer beaches from Monomoy to Eastham and marshes behind them all have large tidal flats attractive to shore birds.

TABLE 5.28 - COLONIAL WATERBIRDS OF THE MASSACHUSETTS COAST, 1976

Species	Approximate Number of Breeding Pairs	Status
Gulls		
Great black-backed	3,000	Relatively stable
Herring	30,000	Declining
Laughing	180	Continuing to decline
Terns		
Arctic	66	Continuing to decline*
Roseate	1,390	Continuing to decline*
Common	5,350	Declining*
Least	1,470	Stable
Double-crested cormorant	1,130	Increasing
Hérons		
Black-crowned night	1,500	Declining
Little blue	10	Probably stable
Louisiana	3	Recent invader
Egrets		
Great	6	Slightly increasing
Snowy	600	Rapidly increasing
Cattle	10	Increasing
Glossy Ibis	75	Recent invader

* Procedures for acquiring "endangered" designation are being initiated.

Threatened Species

Table 5.29 shows wildlife species which exist in limited numbers in Massachusetts and which are known to reside in or visit the Coastal Region. Two species, the Plymouth red-bellied turtle and the beach meadow vole, are known to exist only here. The red-bellied turtle, of which the Plymouth red-bellied turtle is a subspecies, has recently been nominated for review to determine whether it should be proposed for listing as an endangered or threatened species. Other of the listed species are found in greater numbers beyond Massachusetts.

Species presently threatened could eventually join the list of species extirpated from the Coastal Region, from the Commonwealth, or may become extinct. The following, once found in the region, are now extinct:

Heath hen--An eastern subspecies of the western prairie chicken, the heath hen is thought to have inhabited scrubby coastal plains from New Hampshire and probably southern Maine to Virginia and possibly the Carolinas. The last individual died on Martha's Vineyard in 1932.

Passenger pigeon--Once common, the last authentic records for Massachusetts indicate that a pair bred at Plymouth in 1889.

Great auk--The great auk was a penguin-like bird which occurred along the shore. Fragments of its bones have been found among the shell heaps at Ipswich.

Threatened Species

Table 5.29 shows wildlife species which exist in limited numbers in Massachusetts and which are known to reside in or visit the Coastal Region. Two species, the Plymouth red-bellied turtle and the beach meadow vole, are known to exist only here. The red-bellied turtle, of which the Plymouth red-bellied turtle is a subspecies, has recently been nominated for review to determine whether it should be proposed for listing as an endangered or threatened species. Other of the listed species are found in greater numbers beyond Massachusetts.

Species presently threatened could eventually join the list of species extirpated from the Coastal Region, from the Commonwealth, or may become extinct. The following, once found in the region, are now extinct:

Heath hen--An eastern subspecies of the western prairie chicken, the heath hen is thought to have inhabited scrubby coastal plains from New Hampshire and probably southern Maine to Virginia and possibly the Carolinas. The last individual died on Martha's Vineyard in 1932.

Passenger pigeon--Once common, the last authentic records for Massachusetts indicate that a pair bred at Plymouth in 1889.

Great auk--The great auk was a penguin-like bird which occurred along the shore. Fragments of its bones have been found among the shell heaps at Ipswich.

C. Land Uses and Vegetative Cover

Wildlife populations in an area are intimately related to the land use and vegetative cover. Species have different needs for food, protective cover, and resting or nesting sites which must be satisfied by their habitats if the animals are to survive. Wildlife resources in the region include forest species, wetland species, and openland or agriculturally related species. There are also some species which can live in urban environments. Table 5.27 lists the vegetation and wildlife associated with the more important cover types in the region.

About 44 percent of the Coastal Region is upland forest. The forest wildlife habitat may be divided into three types: hardwood, softwood, and mixed hardwood and softwood. The forest stand, of whichever type, can vary in height and density and in associated understory and ground cover. Such differences affect the type and numbers of wildlife present.

Considered openland wildlife are those species which prefer open agricultural land or land which has recently been abandoned and is beginning to revert to woodland through natural plant succession. Almost 8 percent of the Coastal Region is in agriculture or abandoned agriculture.

TABLE 5.27

LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Approximate % of Land in Region	Vegetation Associated with Cover Type			Wildlife Associated with Cover Type		
		Trees	Understory	Plants	Mammals	Birds	Reptiles, Amphibians
Hardwood	18	scrub oak black cherry white oak red maple sugar maple red oak white ash white birch black locust American beech basswood quaking aspen	arrowwood wild raisin spice bush green brier witch hazel sarsaparilla		whitetail deer eastern cottontail gray fox shorttail weasel oppossum shorttail shrew hairy-tailed mole star-nosed mole raccoon eastern chipmunk gray squirrel striped skunk northern flying squirrel white-footed mouse woodland jumping mouse	ruffed grouse screech owl red-tailed hawk hairy woodpecker downy woodpecker yellow-bellied sapsucker blue jay common crow black-capped chickadee white-breasted nuthatch red-breasted nuthatch myrtle warbler scarlet tanager cardinal rufous-sided towhee slate-colored junco white-throated sparrow	spring peeper common garter snake northern black racer eastern milk snake American toad
Softwood	5	pitch pine white pine eastern hemlock other species often in plantations: scotch pine Norway spruce red pine white spruce	green brier honeysuckle		whitetail deer red squirrel.	screech owl long-eared owl blue jay common crow black-capped chickadee slate-colored junco starling pine grosbeak	--
Mixed Hardwood and Softwood	21	scarlet oak black oak white pine eastern hemlock pitch pine American elm sugar maple red maple white ash American beech	arrowwood honeysuckle wild raisin spice bush green brier wild grape wintergreen shining clubmoss partridge- berry	sassafras witch hazel sarsaparilla salt spray rose	whitetail deer eastern cottontail gray fox raccoon striped skunk opossum shorttail shrew star-nosed mole hairy-tailed mole eastern chipmunk gray squirrel red squirrel northern flying squirrel white-footed mouse woodland jumping mouse	ruffed grouse long-eared owl red-tailed hawk yellow-bellied sapsucker hairy woodpecker downy woodpecker blue jay common crow black-capped chickadee white-breasted nuthatch red-breasted nuthatch myrtle warbler scarlet tanager rufous-sided towhee slate-colored junco white-throated sparrow northern oriole evening grosbeak	common garter snake northern black racer eastern milk snake American toad common newt spotted salamander

TABLE 5.27 - cont.

LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Approximate % of Land in Region	Vegetation Associated with Cover Type		Wildlife Associated with Cover Type		
		Woody	Non-Woody	Mammals	Birds	Reptiles, Amphibians
Open Land (Agricultural Land)	5	Trees grown include: domestic fruit trees, ornamental trees and shrubs, Christmas trees	Crops and forage grown include silage corn, vegetable crops, alfalfa, grasses and cranberries in bogs	whitetail deer red fox shorttail shrew eastern chipmunk eastern cottontail woodchuck meadow vole striped skunk opossum	bob-white ring-necked pheasant red-winged blackbird cowbird mourning dove common goldfinch starling	
Open Land (Abandoned Agricultural Land)	2	--	shedbush viburnum highbush blueberry juniper grasses	whitetail deer red fox shorttail shrew eastern chipmunk eastern cottontail meadow vole striped skunk woodchuck	bob-white ring-necked pheasant red-winged blackbird cowbird mourning dove common goldfinch starling	
Heath	1	--	poverty grass beach plum lichens bearberry bayberry poison ivy reindeer moss beach heath	eastern cottontail	bob-white ring-necked pheasant	
Sand	1	--	beach grass dusty miller beach pea poison ivy	--	common teal herring gull great black-backed gull	
Urban	18	ornamental trees	grasses ornamental herbs and shrubs	Norway rat house mouse gray squirrel shorttail shrew eastern mole	rock dove starling English sparrow nighthawk common grackle	
Power Lines	1	trees which do not interfere with primary land use	grass low shrubs		ruffed grouse rufous-sided towhee slate-colored junco	common garter snake northern black racer eastern milk snake American toad common newt spotted salamander

TABLE 5.27 - cont.

LAND COVER AND ASSOCIATED VEGETATION AND WILDLIFE

Land Cover Type	Approximate % of Land in Region	Vegetation Associated with Cover Type			Wildlife Associated with Cover Type		
		Trees	Understory	Plants	Mammals	Birds	Reptiles, Amphibians
Wetland - Fresh Water	11	red maple black willow trembling aspen American elm	speckled alder grasses reeds sedges cattail silky dogwood witch hazel green brier	spice bush highbush blueberry arrowwood honeysuckle	muskrat mink raccoon star-nosed mole little brown myotis eastern pipistrel hoary bat otter beaver	woodcock tufted titmouse catbird cedar waxwing brown thrasher great blue heron eastern green heron kingfisher green-winged teal mallard duck black duck wood duck tree swallow	snapping turtle stinkpot spotted turtle wood turtle eastern box turtle eastern painted turtle eastern ribbon snake spotted salamander northern black racer red-backed salamander American toad spring peeper bullfrog pickerel frog wood frog gray tree frog
Wetland - Salt Water	2	--	cordgrass - salt meadow and salt marsh spike grass salt marsh bulrush black grass ditch reed		muskrat red fox striped skunk	black duck mallard duck great blue heron black crowned night heron osprey marsh hawk	northern diamondback terrapin

Wetlands comprise about 13 percent of the Coastal Region. Of the different types of wetlands, wooded swamps cover the most area. Wooded swamps provide high value food and cover to woodcock, cottontail, hare, and deer and are important nesting and feeding areas to wood and black ducks when the swamp borders open water. The other types, in order of decreasing total area, with notes about their importance to wildlife, are, as follows:

Open Fresh Water--may produce aquatic vegetation of high value to waterfowl; provides food and cover for muskrat, beaver and otter, food for mink and raccoon.

Saltwater Wetland--provide food for wintering ducks, food and cover for muskrat, food for mink and raccoon.

Inland Shallow and Deep Marsh--shallow fresh marsh is a very important type, used by waterfowl for nesting and feeding; deep fresh marsh is the most important inland type - it is used for feeding and, in some cases, nesting by waterfowl; both types provide food and/or cover to muskrat, mink, and a variety of other species.

Shrub Swamps and Bogs--important to waterfowl when it borders permanent open water; shrub swamps provide high value food and cover to woodcock, cottontail, hare, and deer, food and/or cover to other species.

Seasonally Flooded Basins or Flats and Inland Fresh Meadows--seasonally flooded areas are utilized by waterfowl for feeding when flooded;

fresh meadows are used as feeding grounds and for some nesting with favorable conditions. Both types provide food for deer during summer and fall, year-round food for fox, skunk, weasel, raccoon, and food and cover for pheasant.

Plants found in wetlands in the region vary widely, depending on the depth of water, period of flooding, or stage of plant succession.

Nearly all types of land or land uses support or allow some wildlife species. The greater the habitat diversity, the greater the diversity of wildlife species. Edge between field, forest, and wetland, as along a field or powerline, is extremely valuable to wildlife because it provides food and cover in close proximity.

Along with diversity, the extent of habitat is important. An area which would be ideal for a certain species may be useless to that species because civilization has made inroads and destroyed the continuity of the environment.

Land uses and vegetative cover are not static. Changes occur naturally, as plant succession proceeds in areas not managed by man. An abandoned field gradually becomes a young forest while man-caused changes occur more rapidly.

Large increases in urban uses have occurred while land area of agricultural or openland has declined significantly through conversion to urban uses or through natural succession to young forest. Young forest, which provides diversified habitat important to many kinds of wildlife, has become mature forest or has been converted to urban uses. These are continuing trends, and they imply continuing losses of wildlife habitat. Efforts to encourage the preservation of farmland and more active timber harvesting programs which would create openings (in which young forest would succeed) are two ways in which better wildlife habitat could be retained.

Heath is a unique vegetative type found primarily on Cape Cod, Martha's Vineyard, and Nantucket. The low, shrubby vegetation characteristic of heath supports a variety of openland wildlife species. The acreage of heath cover is dropping, as tree species invade and succession produces forest. Some abandoned agricultural land is permitted to succeed to heath, but the amount does not offset the trend. Management is necessary to prevent reversion of the heath to forest.

D. Outstanding Wildlife Resources

Waterfowl

The Coastal Region provides habitat to geese and ducks of many species, both residents and migrants. Of the marsh and pond ducks, the black duck and the mallard duck are common species; the former preferring salt water, the latter, fresh water. Both are Massachusetts' breeding birds. Some Canada geese also breed here and others use the wetlands and coastal waters during migration.

Many migrating species of waterfowl rest and feed in the Coastal Region because two eastern routes of the Atlantic flyway pass through in a north-south direction. Many species winter in the area, enabled to remain by the milder weather of the maritime climate. Species counted on the Massachusetts Division of Fisheries and Wildlife's annual winter inventory include (in order of decreasing numbers): eider, black duck, scaup, Canada Goose, goldeneye, scoter, bufflehead, merganser, and mallard. Thousands of eider are counted in Kingston and Duxbury Bays each winter. Wintering waterfowl number in the hundreds at many locations along the shore of the mainland and islands.

Colonial Waterbirds and Shore Birds

There are between 200 and 300 nesting colonies of waterbirds in the Coastal Region of Massachusetts. They are located mainly on the off-shore islands.

Many, primarily gull and tern colonies, are located on Cape Cod; others are along the mainland.

A survey of colonial waterbirds conducted in 1976 by the Massachusetts Cooperative Wildlife Research Unit disclosed the numbers and species shown in Table 5.28. The numbers of breeding birds are shown to be declining. Among these are the Arctic, roseate, and common terns. Disturbance of their breeding habitat on the dunes is a major factor in the decline. Off-road vehicles are a particular menace. As a counter-measure, the Trustees of Reservations and the Massachusetts Audubon Society is carrying on a program of protecting tern nesting areas and monitoring reproductive success. The Cape Cod National Seashore also protects tern nesting areas within its boundaries.

Several long-legged waders more common to the south are increasing in numbers. Included are the great, snowy, and cattle egret and the glossy ibis.

Thousands of shore birds congregate at specific locations (thought to be chosen because of their rich invertebrate resources) each year to rest

and feed during migration. The bird populations involved would suffer serious consequences if those sites should be lost to them. Important sites for stopping-over in the northeast are the Newburyport and Plum Islands area and Ipswich Beach; in the southeast, Snake Island in Boston Harbor, Third Cliff at Scituate, and the Plymouth Beach and Duxbury Beach area; on the Cape, the outer beaches from Monomoy to Eastham and marshes behind them all have large tidal flats attractive to shore birds.

TABLE 5.28 - COLONIAL WATERBIRDS OF THE MASSACHUSETTS COAST, 1976

Species	Approximate Number of Breeding Pairs	Status
Gulls		
Great black-backed	3,000	Relatively stable
Herring	30,000	Declining
Laughing	180	Continuing to decline
Terns		
Arctic	66	Continuing to decline*
Roseate	1,390	Continuing to decline*
Common	5,350	Declining*
Least	1,470	Stable
Double-crested cormorant	1,130	Increasing
Hérons		
Black-crowned night	1,500	Declining
Little blue	10	Probably stable
Louisiana	3	Recent invader
Egrets		
Great	6	Slightly increasing
Snowy	600	Rapidly increasing
Cattle	10	Increasing
Glossy Ibis	75	Recent invader

* Procedures for acquiring "endangered" designation are being initiated.

Raptors

Two uncommon raptors, the peregrine falcon, considered endangered, and the American osprey, "status undetermined", may be seen in the Coastal Region. The American osprey breeds in the region. Its numbers were severely depleted by the effects of pesticides and loss of habitat in its nesting areas. The best reproduction in the state is found near Westport in Bristol County. In 1976, 24 young were produced there from 11 nests. The birds have been moving into other areas in recent years, including: Wareham, Mashpee, Martha's Vineyard, and Naushon Island.

The peregrine falcon has also been a victim of pesticides. No longer a breeding species in Massachusetts, less than a dozen migrants can now be observed in the Coastal Region.

Song Birds

A great variety of song birds are found in the Coastal Region of Massachusetts as residents, migrants, or visitors. From 1966 to 1975, the Manomet Bird Observatory banded 146 species of song birds. Most numerous was the black-capped chickadee. The rare Ipswich sparrow is a winter resident of the Coastal Region. The great variety of bird species is related to the variety of habitat types available.

Threatened Species

Table 5.29 shows wildlife species which exist in limited numbers in Massachusetts and which are known to reside in or visit the Coastal Region. Two species, the Plymouth red-bellied turtle and the beach meadow vole, are known to exist only here. The red-bellied turtle, of which the Plymouth red-bellied turtle is a subspecies, has recently been nominated for review to determine whether it should be proposed for listing as an endangered or threatened species. Other of the listed species are found in greater numbers beyond Massachusetts.

Species presently threatened could eventually join the list of species extirpated from the Coastal Region, from the Commonwealth, or may become extinct. The following, once found in the region, are now extinct:

Heath hen--An eastern subspecies of the western prairie chicken, the heath hen is thought to have inhabited scrubby coastal plains from New Hampshire and probably southern Maine to Virginia and possibly the Carolinas. The last individual died on Martha's Vineyard in 1932.

Passenger pigeon--Once common, the last authentic records for Massachusetts indicate that a pair bred at Plymouth in 1889.

Great auk--The great auk was a penguin-like bird which occurred along the shore. Fragments of its bones have been found among the shell heaps at Ipswich.

TABLE 5.29 - MASSACHUSETTS WILDLIFE SPECIES EXISTING IN LIMITED NUMBERS (Continued)
WHICH ARE FOUND IN THE COASTAL REGION

Species	Distribution	Estimated Numbers	Typical Habitat	Status ²
<u>Reptiles</u>				
Plymouth red-bellied turtle	Scattered ponds in Plymouth County, Naushon Island and possibly Ipswich.	Probably less than 200.	Quiet, shallow warmwater ponds.	Endangered
Northern diamondback terrapin	Buzzards Bay and Cape Cod Bay from Barnstable to Wellfleet.	Unknown	Salt marshes, tidal creeks, and estuaries.	Undetermined
Eastern box turtle	Statewide	Unknown	Fields, meadows, open woodlands, usually near water.	Undetermined
Timber rattlesnake	Blue Hills Reservation, Milton, Norfolk County and areas in western Massachusetts.	Unknown	Rocky fields, woodlands, and mountainsides.	Endangered
Northern copperhead	Blue Hills Reservation, Milton, Norfolk County and areas in western Massachusetts.	Unknown	Rocky, wooded hillsides, often moving to bottomlands during the summer.	Undetermined
Blue-spotted salamander	Recorded from various areas of Middlesex County; Springfield, Hampden County; a few Essex County towns; Attleboro, Bristol County.	Unknown	Lives underground in moist woodland.	Endangered
Spotted salamander	Statewide	Unknown	Lives underground in moist woodland.	Threatened
Marbled salamander	Principally Worcester County, with remnant colonies in Middlesex, Plymouth, and Bristol Counties.	Unknown	Woodlands	Threatened
Four-toed salamander	Scattered from Connecticut River Valley eastward to Cape Cod.	Unknown	Swamps, sphagnum bogs, acidic meadows.	Undetermined

¹ From Mugford, P.S., 1975. An Inventory of Massachusetts Fish and Wildlife (Vertebrate) Resources, Massachusetts Division of Fisheries and Wildlife, Boston.

² Definitions from Mugford, 1975, page 54:

Pere - not immediately in peril and possibly stable at present, but existing in such low numbers or with such a restricted distribution that the entire species population could be seriously jeopardized by catastrophic events occurring within its range.

Endangered - in immediate danger of extinction or extirpation from the state due to critically low or drastically declining populations brought about by habitat modification, overexploitation, pollution, diseases, or other factors.

Status Undetermined - not in immediate danger of extinction or extirpation, but showing signs of decline and causing justifiable concern; or being little known or apparently uncommon and possibly could be jeopardized by inadvertent actions. More information required to properly evaluate status.

Peripheral - reaches the limit of its usual range outside Massachusetts. Occasional individuals or stragglers may be found, but no breeding populations within the state.

Threatened - likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range.

TABLE 5.29

MASSACHUSETTS WILDLIFE SPECIES EXISTING IN LIMITED NUMBERS¹
WHICH ARE FOUND IN THE COASTAL REGION

Species	Distribution	Estimated Numbers	Typical Habitat	Status ²
<u>Mammals</u>				
Moose	Occasional stragglers range into northeastern, central, and western parts of the state.	None resident. Regular stragglers.	Wilderness areas of early successional mixed stands interspersed with bogs and shallow ponds.	Peripheral
Gray seal	Muskeget and Tuckernut Islands, Nantucket County and adjacent waters.	12 - 18	In Massachusetts - shallow seas adjacent to sand bars and low islets.	Rare
Southern bog lemming	Plymouth County	Unknown	Bogs; dense swamps; cool, dense forest undergrowth.	Undetermined
Beach meadow vole	Known only Muskeget Island, Nantucket.	5,000 - 15,000	Sandy beaches overgrown with beach grass.	Rare
<u>Birds</u>				
American peregrine falcon	Coastal areas.	No breeders, migrants usually number less than a dozen annually.	Nests on high cliffs or ledges frequently overlooking water bodies or valleys.	Endangered
American osprey	Principally in Bristol, Barnstable, and Dukes Counties.	A few dozen in breeding season.	Isolated coastal or inland sites adjacent to sizeable bodies of water.	Undetermined
Laughing gull	Coastal, especially Cape Cod.	About 150-200 pairs in breeding population.	Salt meadows, shores of tidal creeks, grassy islets.	Undetermined
Common tern	Coastal beaches and islands, Plum Island south to Elizabeth Islands.	Fewer than 5,000 pairs.	Sandy beaches and island shores.	Undetermined
Arctic tern	Outer Cape Cod and offshore islands.	Probably less than 50 pairs.	Rocky or sandy coastal and island beaches and shores.	Undetermined
Least tern	Coastal beaches from Essex County south to Bristol County.	Probably less than 1,000 pairs.	Broad, flat, sandy beaches on mainland and coastal islands.	Undetermined
Short-eared owl	Nesting limited to coastal areas south to Cape Cod.	Unknown	Open plains, scrub flats, dunes, and marshes.	Undetermined
Eastern bluebird	Transient statewide, limited breeding.	Unknown	Open woods, swamps, rural roadsides, farmland, burnt over areas.	Undetermined

Labrador duck--This was a winter visitor, already rare by the early 1800s. The last specimen taken in the state was shot at Swampscott in 1862.

Important Wildlife Areas

There are many areas within the Coastal Region which are of special importance to wildlife. A few of them are listed in Table 5.30. In addition to those in government ownership, Massachusetts is fortunate to have many areas preserved by such groups as the Trustees of Reservations and the Massachusetts Audubon Society. Other areas, in private ownership, may or may not continue to serve the needs of wildlife as the human population grows and urbanization spreads.

5.9 RECREATION

The analysis of recreation supply, demand, needs, and alternatives has been limited to those outdoor recreation activities which are water-related or which are normally assumed to be enhanced or complimented by adjacent water bodies. These activities include swimming, camping, picnicking, canoeing and sailing, and hiking. The primary data source for recreation has been the 1976 Statewide Comprehensive Outdoor Recreation Plan (SCORP) prepared by the Massachusetts Department of Environmental Management. A basic data source for the SCORP was the "Inventory of Private Recreation" published by the National Association of Conservation Districts.

TABLE 5.30 SOME IMPORTANT WILDLIFE AREAS 1/

Location	Type	Ownership/Management	Remarks
<u>Northeast</u>			
Northeast Wildlife Management Area, Newbury	Upland	State-Mass. Division of Fish & Wildlife, 1,453 acres	Pheasants, grouse, woodcock, ducks, deer, raccoon, cottontail rabbit, snowshoe hare, gray squirrel
Parker River - Plum Island Newbury, Rowley, Ipswich, Newburyport	Estuary - island	Federal-U.S. Fish & Wildlife Service - Parker River National Wildlife Refuge 6,417 acres	Many shorebirds, waterfowl nesting, Pheasant, deer, bobolink nesting, waterfowl
Mill Creek Wildlife Management Area, Newbury, Rowley	Upland & wetland	State-Plum Island State Park, 76 acres & private	
Essex marshes, Essex	Coastal marshes, estuary	State-Mass. Division of Fish and Wildlife, 656 acres	
		Private	Shorebirds, waterfowl nesting, nesting
<u>Southeast</u>			
Boston Harbor Islands	Islands	Administration by Mass. Dept. of Environmental Management and Metropolitan District Commission	Nesting of colonial waterbirds, including herons
Hockamock Swamp, Bridgewater	Inland wetland	Mass. Div. of Fisheries & Wildlife, 4,600 acres, and private	Deer, furbearers, waterfowl, especially migrants
Blue Hills Reservation	Upland	Metropolitan District Commission, 5,489 acres	Endangered timber rattlesnake, status undetermined, northern copperhead
Myles Standish State Park, Carver, Plymouth	Upland	State 12,461 acres	Deer, ruffed grouse, cottontail rabbit, bobwhite quail, bluebirds
Acushnet White Cedar Swamp, New Bedford	Inland wetland	1,800 acres state and local government, private organization, private	Wetland wilderness in urbanized area
Westport River	Estuary - islands	Island, Mass. Audubon, town	Osprey nesting (best reproduction in NE), also black-crowned night heron, green heron
			Bird nesting, snowy egrets
North-South River, Scituate, Marshfield	Estuary	Local, government, private organizations, private	
Clarks Island, Plymouth Harbor	Island	Private	Mating bird rookery
Rocky Gutter Wildlife Management Area, Middleborough	Inland wetland	State-Mass. Div. of Fish & Wildlife, 1,541 acres	Upland game, waterfowl
Cape Cod and Islands			
Otis Air Force Base, Mashpee	Upland	State, leased to military	Deer, ruffed grouse, woodchucks, bobwhite quail
Monomoy Island, Chatham	Island	U.S. Fish & Wildlife Service, 2,698 acres	Shorebirds, deer
Cape Cod National Seashore-Chatham, Provincetown, Orleans, Wellfleet, Truro	Coastal wetlands, Outer beaches, marshes	National Park Service, private	Shorebirds, bay and sea ducks
Muskeget & Tuckernuck Islands, Nantucket	Islands	Town (part of Muskeget Is.) and private	
Elizabeth Island, Gosnold	Islands	Private, except Penikese Island, 60 acres Mass. Div. of Fisheries & Wildlife	Rare gray seal and on Muskeget Island, rare beach meadow vole
			Deer, bird nesting, including heronry on Naushon Island relatively undeveloped

1/ Included are only a few of the more important wildlife areas in the Coastal Region. Some support unique species, but others provide habitat for more common species which have less habitat available to them with each passing year. Only those areas in public or quasi-public ownership will definitely continue to be important in the future. Their use cannot change.

The available supply of recreation resources was obtained from adjusted figures for SCORP Regions IV (partial), V, VI, VII. The supply figures give a good indication of the extent of outdoor recreation available in the Coastal Region.

TABLE 5.31 - SUPPLY OF SELECTED RECREATION ACTIVITIES

Activity	Supply (1000 Activity Days)
Swimming	51,750
Camping	1,770
Picnicking	1,693
Canoeing - Sailing	4,428
Hiking	1,223

In addition to the recreation resources that can be quantified by the activity-days that they provide, the Coastal Region boasts a number of "landscape and natural areas" which provide a largely unquantified amount of passive recreation and enjoyment. These areas which have been identified in the 1974 Massachusetts Landscape and Natural Areas Survey include natural areas with unique scenic, historic or scientific significance. There are a total of 318 of these natural areas located in the region; of these, 172 sites are owned by governments, private conservation organizations, or institutions. One hundred and forty-six of the natural areas are wholly or partially owned by private individuals. Ownership of the natural areas is quite important in determining public access to enjoy the resource. The vulnerability of the area to disruption and even possible loss through development is also dependent upon ownership and owner attitude. In some cases, the publicly owned areas are in jeopardy while some privately owned areas are safe and zealously protected by the owner.

Although not a natural resource, the region's many historic and cultural sites are an important factor in the total recreation picture. Days and weeks can be spent enjoying the tourist-oriented Freedom Trail in Boston, the Mayflower II in Plymouth, Mashpee Wampanoag Indian Museum, Plimouth Plantation, Provincetown Museum, the Whaling Museum in New Bedford, and numerous individual historic buildings harkening back to an earlier time. The region has nearly 250 properties listed in the National Register of Historic Places; of these, 71 have been designated as National Historic Landmarks. Cultural resources such as the Boston Symphony and Boston Pops Orchestra with world-wide fame add to the recreation supply.

Nearly half of the 35-rivers identified in the SCORP report as providing excellent potential for development as canoe trails are located in the Coastal Region. The Wampanoag Sachems Canoe Passage has been designated along 72 miles of the North, Matfield, Satucket, and Taunton Rivers. Table 5.32 indicates the portions of river identified for this purpose.

TABLE 5.32 - POTENTIAL CANOE TRAILS

River	Section of River
Ipswich River	Ipswich to Reading
Ten Mile River	Attleboro to Rhode Island
Wading River	Wrentham to Dighton
Town River	West Bridgewater to Bridgewater
Satucket-Matfield Rivers	East Bridgewater to Bridgewater
Nemasket River	Middleborough
Acushnet River	Acushnet
Mattapoissett River	Mattapoissett to Rochester
Weweantic River	Wareham
Wankinko River	Wareham
Agawam River	Wareham
Mashpee River	Cape Cod
Cotuit River	Cape Cod
Bass River	Cape Cod
Harwich River	Cape Cod
Herring River	Cape Cod
Sippican River	Rochester to Marion

The SCORP report also identifies several rivers which should be considered for protection under the Scenic and Recreational Rivers Act, Chapter 21, Section 17B of the General Laws. These rivers are included in Table 5.33.

TABLE 5.33 - POTENTIAL SCENIC AND RECREATIONAL RIVERS

River	Section of River
Taunton River	Paper Mill Village, Bridgewater to Route 44 bridge
North River	Entire river
South River	Entire river
Ipswich River	Middleton to mouth of river

There are more than 430 ponds and lakes, 20 acres and over in size, located within the region. These provide more than 44,000 acres of surface water resources. Surface water bodies are used for municipal water supply, fishing, fish and wildlife habitat, swimming, boating, as well as for visual contrast and aesthetic pleasure.

Access to freshwater bodies in the region is usually a function of their ownership and use. These reservoirs used for municipal water supply normally have restrictions upon public access and use. Swimming or wading is prohibited in all except supplementary, emergency supplies. Fishing and boating is also restricted, although there may be scattered instances of tightly-controlled reservoir fishing. Public access to the ponds, lakes, and reservoirs of the region is detailed in Appendix C prepared for the study by the Massachusetts Division of Water Resources.

The nearly 1,200 miles of saltwater shoreline do much to meet the outdoor recreation demand in the region and reduce the demand on freshwater recreation facilities. The SCORP study inventories nearly 75 miles of beachfront in the region. The beaches of Cape Cod and the Islands attract millions of users during the summer. The coastal resource also provides opportunity for much of the power boating enjoyed in the area.

Government provides numerous recreation opportunities throughout the region. The National Park Service is in the process of acquiring an additional 700 acres of land before 1980 to add to the Cape Cod National Seashore. Potential area within the authorized boundaries of The National Seashore includes over half of the "forearm" of Cape Cod. Another significant federal recreation resource is the development along the Cape Cod Canal maintained by the Army Corps of Engineers. The Canal complex provides fishing, hiking, and camping opportunities. The U.S. Fish and Wildlife Service manages three refuges in the region: the Monomoy National Wildlife Refuge at the "elbow" of Cape Cod, the Parker River National Wildlife Refuge (Plum Island) in Newbury and Rowley, and Nomansland Island off Martha's Vineyard.

The state government is the largest landholder of open space and recreation acreage in Massachusetts. The Division of the Department of Environmental Management most concerned with open space and recreation is Forests and Parks. The Division of Fisheries and Wildlife in the Department of Fisheries, Wildlife and Recreation Vehicles is concerned with water related recreation. The Metropolitan District Commission (MDC) which provides municipal water and sewerage service to much of the metropolitan Boston area also is responsible for parks and recreation in the same area.

The MDC manages over 11,000 acres for recreational enjoyment. The Trustees of Reservations are responsible for the management of nearly 4,500 acres of natural areas which are used extensively for passive recreation.

Town conservation commission land and town forests also serve to fill a need for passive recreation close to population centers.

Private lands which are open to the public for passive enjoyment are also important in the region. The Massachusetts Audubon Society controls nearly 4,000 acres of land which is managed for wildlife habitat and which also provides hiking trails and opportunities to observe and enjoy the natural beauty of the areas. The Audubon Society of Rhode Island controls Caratunk Refuge in Seekonk, Massachusetts.

Three major state recreation projects will be completed in the Coastal Region before 1990. These include the Boston Harbor Islands Park System. Sixteen of the 30-islands in Boston Harbor are already within the system. The Park will combine conservation and recreation based on a plan that emphasizes the unique, natural and man-made characteristics of these islands.

The Metropolitan Park System will involve expansion and further development of Boston's Franklin Park. A zoological garden with an all-weather African exhibit will provide the focus for the Park. The Neponset Reservation and Blue Hills Reservation may also be included in this development plan.

The South Cape Beach in the town of Mashpee is the third major park program slated for the region. Four hundred acres of land including marsh areas, two freshwater ponds, and about 25 miles of beachfront are included in the plans. The objectives are to expand public shorelines, as well as preserve a major conservation area within a developing region.

The undeveloped 450-acre Hawk's Nest State Park in Harwich offers potential for trails, camping, fishing, and swimming.

5.10 EXISTING PROGRAMS

Information on programs which affect the resources considered in this study are summarized in the following Tables and Figures.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use	Municipalities	<p>Massachusetts General Laws, Chapter 61A, Sections 1-24 - The Agricultural and Horticultural Assessment Act. The act is designed to provide economic incentives in the form of lower property taxes to encourage maintenance of productive agricultural or horticultural pursuits. The act also has the effect of preserving open space. Massachusetts is one of 32 states that provide for such assessments. This act is sometimes referred to as the "Current Use Taxation of Farmland and Horticultural Land."</p> <p>Massachusetts General Laws, Chapter 184, Sections 23-33 - An act to protect conservation and preservation restrictions which are held by an appropriate public authority.</p> <p>Massachusetts General Laws, Chapter 61, Sections 1-7 - The Classification and Taxation of Forestlands (General Laws, Chapter 61) as amended. Landowners who have at least 10 contiguous acres of forestland having a value not over \$400 an acre (land and timber) may apply to their local tax assessors to have their forestland classified under the law. If the state forester determines that the woodland owner qualifies, the land and timber are taxed separately. The land is assessed at not more than \$10 per acre and annual taxes are paid on this basis. Also, a forest products tax of 8 percent is paid on the value of forest products harvested. A rollback applies if the land is withdrawn from the forest classification. In addition to the tax incentive program for private landowners there is a forest management program for public forest holdings.</p>
	Municipalities	
	Municipalities, Mass. Division of Forests and Parks	
	Soil Conservation Service, Conservation District, landowners	<p>Conservation Operations Program - Proper land treatment is the basic concern of the Soil Conservation Service. This is the purpose of the Conservation Operations Program which provides technical assistance and advice on soil and water conservation to land users through local conservation districts.</p> <p>In the region, requests for assistance go to the Cape Cod, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, or Plymouth Conservation District which determines priorities for the Conservation Operations Program. The district is an arm of state government, having five unpaid supervisors whose job it is to consult with and advise the local SCS staff in scheduling their work load.</p> <p>Practices applied in the Conservation Operations Program include improved agronomic practices, measures to reduce soil erosion, practices designed to help carry water safely off sloping land, drainage improvements, and comprehensive measures to improve wildlife habitat and recreational areas.</p>
	Farmers Home Administration, landowners	<p>Soil and Water Loans - These loans are to facilitate improvement, protection, and proper use of farmland by providing adequate financing and supervisory assistance for soil conservation; water development, conservation and use; forestation; drainage of farmland; the establishment and improvement of permanent pasture; and related measure. Loans cannot exceed \$100,000.</p>
	U.S. Agricultural Stabilization and Conservation Service, landowners	<p>The Agricultural Conservation Program (ACP), provides cost sharing assistance to farmers and other landowners who undertake soil, water, forest and wildlife conservation practices. The cost for such practices is shared between the federal government and the landowner. Technical assistance for ACP practices is rendered by the Soil Conservation Service, the Extension Service, and the U.S. Forest Service in cooperation with the Massachusetts Division of Forests and Parks.</p>

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use	Municipalities	<p>Zoning Enabling Act, Mass. General Laws Chapter 40A - The Act contains the basic authority for municipal zoning, predicated on the traditional police power concept of the promotion of health, safety, morals and general welfare. The Act authorizes municipalities to enact zoning laws designed among other purposes to lessen congestion in the streets, to conserve health; to secure safety from fire, panic and other dangers; provide adequate light and air; to prevent overcrowding of land; to avoid undue concentration of population; to facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirements; to conserve the value of land and buildings; to encourage the most appropriate use of land throughout the city or town; and to preserve and increase its amenities.</p> <p>Zoning may regulate and restrict the height, number of stories, and size of buildings and structures, the size of width of lots, the percentage of lot that may be occupied, the size of yards, courts and other open spaces, the density of population, and the location and use of buildings, structures and land for trade, industry, agriculture, residence or other purposes.</p>
	Municipalities	<p>Earth Removal-Mass. General Laws Chapter 40, Section 21 (17) and Chapter 40A, Section 2 - Municipal regulation of the extraction of removal of soil, sand, gravel, and other minerals was first carried on under the Zoning Enabling Act, which specifically authorizes municipalities to "regulate and restrict the...use of land...and (to) prohibit noxious trades within the municipality or any specified part thereof." The state legislature further empowered municipalities to enact nonzoning bylaws "prohibiting or regulating the removal of soil, loam, sand or gravel from land." In addition to exempting public land, the nonzoning bylaw must exempt earth removal which is part of site preparation for an approved subdivision or which is "the subject of a permit or license issued under the authority of the town." Because of these limitations, communities may and often do use both types of bylaws to ensure adequate coverage.</p> <p>Typically, such bylaws require a permit for earth removal and impose certain conditions upon the operation as a prerequisite to obtaining such a permit. Conditions may include, for example, control of drainage, maintenance of buffer zones along wetlands or public ways, screening and fencing, measures to reduce dust, limitation of the hours of operation; and grading, regrading, regrading and reseeding after the work is done. Some eight municipalities have passed bylaws entirely prohibiting earth removal activities, except those absolutely necessary for preparation of a building site.</p>
	Mass. Dept. of Agriculture	<p>Agricultural Preservation - Chapter 780 of the Acts of 1977 allows the state to protect and encourage agriculture by the acquisition of agriculture preservation restrictions.</p>

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service, municipalities	<p>The SCS has the federal leadership for conducting the National Cooperative Soil Survey. In Massachusetts, the soil survey is carried on cooperatively with the Massachusetts Agricultural Experiment Station. Soil survey activities include the mapping, classification, correlation, and interpretation of soils according to national standards. The surveys are a basic scientific inventory of soil resources, based on soil properties. These surveys identify the kinds of soils, their extent, location and characteristics.</p> <p>Soil surveys play a vital part in planning by:</p> <ol style="list-style-type: none"> 1. Providing a permanent inventory of the soil resources, 2. providing soil interpretations for various uses to guide planners at the local, regional, and state levels in making sound land use decisions for developing comprehensive plans, 3. providing data on the location of: <ol style="list-style-type: none"> a. wetlands, steep land, rocky land and areas with a high water table b. areas suitable for waste disposal c. areas that are suitable for use as residential, commercial, industrial, or school sites 4. providing many other soil interpretations that contribute to planning for a better quality environment. <p>Many communities need, and want, soil survey information before the report is published in the usual manner. To provide this information ahead of the published report time, the SCS in Massachusetts prepares special soils reports for those communities which help pay for cost of preparation.</p> <p>A town soils report consists of a narrative description of each soil found within the community, copies of the soil survey mapping sheets and interpretative maps. These interpretative maps show the limitations of the soils for selected uses, such as sewage disposal, home sites or industrial sites. See Figure 5.18 for the status of the soil survey in the region.</p> <p>U.S. Soil Conservation Service, other USDA agencies The Pilgrim Resource Conservation and Development Area - The Resource Conservation and Development (RC&D) Area is a locally initiated, sponsored and directed program which is planned to accelerate the conservation and development of natural resources; improve the general level of economic activity; and enhance the environment and standards of living. Each RC&D plan has its own unique goals. RC&D areas are sponsored by Conservation Districts and town and county municipalities, governments, and may include municipalities, state agencies, comprehensive planning agencies and local nonprofit organizations.</p>

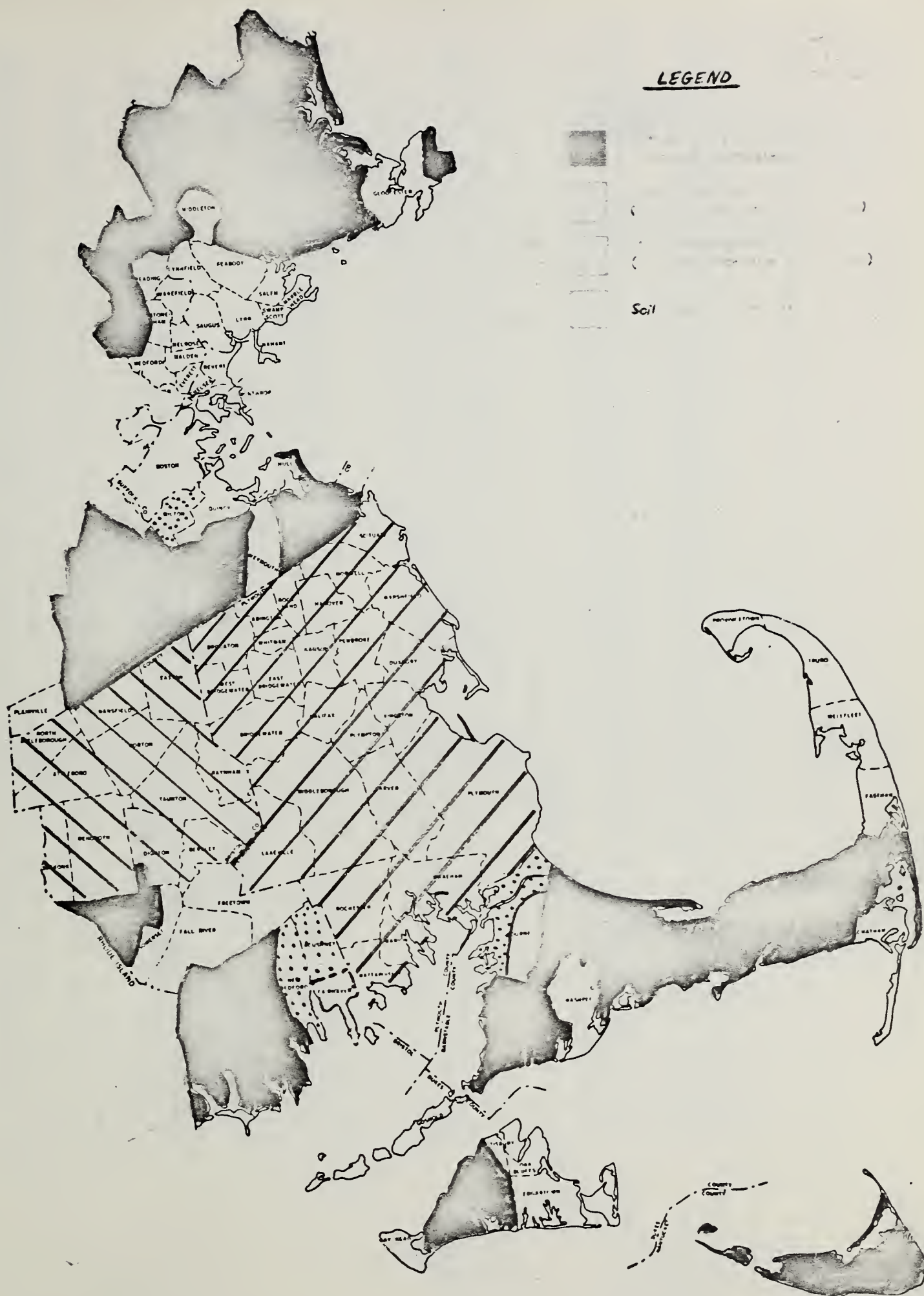


Figure 5.18
STATUS OF SOIL SURVEYS

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service Extension Service vice, Mass. Natural Resources agencies	<p>Natural Resource Inventories - These studies identify and describe areas with natural resource development potential within the community. Each area is described and its alternative development potentials are listed in a report. Opportunities and problems in the use of each site or areas are identified and discussed.</p> <p>The Soil Conservation Service, County Regional Extension Service, Massachusetts Division of Forests and Parks, Massachusetts Division of Fisheries and Wildlife and other agencies conduct natural resource inventories for communities. A community wishing a natural resource inventory requests help from the Conservation District which, in turn, arranges for the inventory.</p> <p>Status of the Natural Resources Inventory Program is shown on Figure 5.19.</p>
Land Use Forest-land	U.S. Forest Service, Mass. Division of Forests and Parks, landowners	<p>Renewable Resources Program - The Forest Resources Planning Act of 1974 provides for long-term planning for the management, protection and utilization of all renewable resources on forestland. The Forest Service and the Massachusetts Department of Environmental Management, Division of Forests and Parks, cooperatively conduct forestry programs on state and privately owned forestland. The forest resources of the Central Region also benefit from research in various aspects of forestry conducted at 80 different laboratories and other scientific facilities. These activities are grouped into five systems: recreation, wildlife, timberland and water, human and community development.</p> <p>Recreation System - The goal of this system is to increase the supply of outdoor recreation opportunities and services through programs which emphasize dispersed recreation. Assistance is given private forest landowners who are interested in helping provide public recreation opportunities, or integrate multiple uses into their forest management programs.</p> <p>Research is conducted to strengthen technology and understanding of recreation demands, trends, values and environmental impacts, as well as quantify and rank commodity and amenity values.</p> <p>Wildlife System - This system provides for increased use and enjoyment of wildlife while increasing both the diversity and numbers of fauna and the protection of threatened and endangered species. Technical assistance and financial incentives encourage nonindustrial private forest landowners to include habitat protection and development among their own management objectives.</p> <p>Research emphasizes habitat identification and improvement for endangered species and the impact of alternative forest practices on game and nongame habitats and populations.</p> <p>Timber System - The goal for the timber system is to increase timber supplies and quality to the point where benefits are commensurate with costs. Opportunities to increase timber supply exist on small private holdings, as well as, on Massachusetts state-owned forest areas. The program provides incentives for private timber landowners to grow commercial timber and for improved use of the trees and logs that are harvested.</p> <p>Major research includes better utilization of timber; improving the rates of timber growth and yield, improving the protection for forests from wild fire, insects and diseases; and providing better inventory and evaluation of resources.</p>



Figure 5.19
STATUS OF NATURAL RESOURCES INVENTORY

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service, other USDA agencies municipalities, Conservation Districts cont.	<p>The Pilgrim RC&D Area cover the southern half of the Coastal Region including Plymouth, Bristol, Barnstable, Dukes and Nantucket Counties. Goals of the plan include:</p> <ol style="list-style-type: none"> 1. Completion of the Soil Survey and other natural resource inventories of the RC&D area and making this information accessible to planning boards and others charged with land use decisions. 2. Development of a watershed treatment and management program to minimize damages due to flooding, erosion, and sedimentation and to provide improved water storage for all purposes. 3. Development of a coastal zone improvement program including pollution abatement, proper land use, and erosion control. 4. Expansion of outdoor recreation areas to meet the needs of the people and protection, development, and management of historic sites, scenic vistas, and unique natural areas and tourist attractions. 5. Establishment of adequate sewage disposal systems, solid waste collection and disposal systems, adequate water supplies, and elimination of pollution and unsightly features to improve the general appearance of urban and rural areas. 6. Development of ample markets and marketing opportunities for wood and agricultural products and a quality vocational training program to develop needed skills. Expansion of the forestry program to promote urban-environmental forestry, forest wildlife habitat, recreation, aesthetics, high value timber species, and multiple use principles. 7. Development of a public education and information program to acquaint people with the RC&D program and to work with school officials in developing a school curriculum with conservation and environmental considerations. 8. Development of a close working relationship with planning agencies and governing officials for maximum effectiveness in coordinating programs, funding and technical expertise.

Cost sharing is available through the RC&D program to assist sponsors with the installation of eligible measures.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use cont.	U.S. Soil Conservation Service, Extension Service, Mass. Division of Forests and Parks, Mass. Division of Fisheries and Wildlife, Conservation Districts, municipalities	<p>Natural Resources Planning Program - The NRPP provides for local communities to inventory their present natural resources, to rate those resources against standards and criteria, to determine the consequences of proposed actions on natural resource base, and to plan the most acceptable future course of action to maintain or improve the community's level of environmental quality.</p> <p>The Natural Resources Planning Program:</p> <ol style="list-style-type: none"> 1. Gives citizens the major role, with local people doing most of the work, making all the decisions, and implementing any needed changes in community policies to meet their goals, 2. closely relates the community's natural resources base to numbers of people the natural resources can safely support, 3. provides help from regional technical teams that represent many agencies and disciplines. The teams are composed of personnel from the Soil Conservation Service, Cooperative Extension Service, Massachusetts Division of Fisheries and Wildlife, and Massachusetts Division of Forests and Parks. Other state and federal agencies assist as requested. The Conservation District accepts applications from communities requesting the program, screens the applications, establishes priorities for assistance by the technical teams, and coordinates agency assistance to the selected communities, 4. includes standards and criteria for rating the resource base, 5. is "open ended": Local citizens can continually monitor their area's natural resource condition and update land use plans as needed. <p>One of the most important aspects of the program is its emphasis on citizen involvement. Local citizens provide the personnel to: (1) inventory, in detail, the present natural resources of their community (2) rate these natural resources against existing standards and criteria (3) identify problem areas (4) assess alternative courses of action (5) prepare a definite plan of action and then, (6) implement planned measures to maintain or enhance their natural resources to achieve the community's selected level of environmental quality. Whatever course of action a community chooses, through use of the program, the community will know in advance the likely consequences of those actions on the natural resource base.</p> <p>Coastal Region communities participating in the Program are indicated in Figure 5.20.</p> <p>Resource Conservation and Development Loans - These loans are to assist sponsoring public agencies in Resource Conservation and Development (RC&D) Areas. Loan funds may be used for (1) rural community public outdoor-oriented water-based recreational facilities; (2) soil and water, development, conservation control and use facilities; (3) community water storage facilities. Loans cannot exceed \$250,000.</p>
	Farmers Home Administration, RC&D sponsors	



Fig. 5. 20
 COASTAL REGION COMMUNITIES PARTICIPATING
 in the
 NATURAL RESOURCES PLANNING PROGRAM

EXISTING PROGRAMS

Subject	Agency	Law or Program
Land Use Forest- land cont.	U.S. Forest Service, Mass. Division of Forests and Parks, landowners cont.	<p>Land and Water System - The land and water system is an aggregation of many basic stewardship and land treatment activities to meet minimum air and water quality standards. This system permits control of man-caused erosion on state and private forestlands through technical assistance and program support.</p> <p>Important areas of research include the nature and extent of nonpoint sources of pollution, improved logging practices for fragile soils and steep slopes, and improved efficiency of fire prevention and firefighting operations.</p> <p>Human and Community Development System - This system is concerned with the relationships between man and his forest environment. All renewable resource programs are focused to increase goods and services from forestland; this means serving employment, housing and other social needs.</p> <p>Assistance to communities is provided for urban and community forestry, rural community fire protection and land use planning. Conservation education and manpower training programs are designed to enhance the knowledge and skills of rural residents.</p> <p>The Massachusetts Department of Environmental Management and the Massachusetts Department of Fisheries, Wildlife and Recreational Vehicles are applying multiple-use management to approximately 35,000 acres of forestland under their jurisdiction as authorized under General Law 132, Section 31, and General Law 131, Section 6.</p>
Flooding	Mass. Natural Resource Agencies U.S. Soil Conser- vation Service, state and local governments U.S. Forest Service	<p>Public Law 83-566, The Small Watershed Protection and Flood Prevention Program - PL-566 provides federal technical, and financial assistance to states, local communities, conservation districts, and other groups in solving their land and water problems.</p> <p>Project purposes which may be included in a PL-566 watershed plan include: conservation land treatment, flood prevention, agricultural water management, industrial and municipal water supply, recreation and fish and wildlife. Flood prevention must be a major concern in each project. PL-566 watersheds are limited to 250,000 acres in size. The program applies to land and water resource problems which cannot be solved by individual landowners on their own property.</p> <p>The PL-566 watershed program helps improve the quality of the natural resource base, the quality of the environment and the quality of the standard of living by:</p> <ol style="list-style-type: none"> 1. reducing erosion and sedimentation through the application of land treatment practices, 2. identifying flood hazard areas for flood plain management measures, 3. promoting proper land use and management, 4. improving agricultural water management practices, 5. providing multiple purpose reservoirs for recreation, fish and wildlife, and water supply, 6. reducing flood damages, hazards to life and health, and the inconvenience caused by flooding.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Flooding cont.	U.S. Soil Conservation Service, state and local governments cont.	<p>In the Coastal Region, eight watersheds are, or have been, involved in the PL-566 program. See Figure 5.20 for location of these watersheds.</p> <p>The Little River in Newbury and Newburyport was authorized for Work Plan preparation in 1963. A preliminary investigation found that a PL-566 project would be feasible to provide flood protection to agricultural land and water-based recreation. The agricultural land was later taken out of production and promoted as an industrial park. In 1969, the mayor of Newburyport was in opposition to use of one of the dam sites for flood control purposes. In view of the changed conditions and lack of local support, planning assistance to the watershed was terminated.</p> <p>An application for planning assistance for the Ipswich River Watershed covering 86,000 acres was submitted in 1963. Watershed problems included flooding of residences and commercial business, municipal water supply, and a lack of water-based recreation. Preliminary investigations showed flooding of cellars to be a combination of high groundwater levels and overland flooding. Filling of wetlands and loss of natural flood storage was also a problem. The Water Resources Commission prepared an independent study of the water supply situation which ultimately recommended a pumped storage site in Ipswich. Local interest in developing a flood control project in the watershed was not strong and the project is now in an inactive status.</p> <p>The Pine Tree Brook Watershed in Milton, Massachusetts is the only completed PL-566 project in the Coastal Region. Flood protection for an urban area of Milton is provided by conservation land treatment and a multiple-purpose wildlife habitat and floodwater retarding structure. The dam controls about 53 percent of the Pine Tree Brook Watershed.</p> <p>Project sponsors include the town of Milton and the Norfolk Conservation District.</p> <p>The Diamond Brook Watershed in Walpole, Massachusetts has recently been approved for installation. Measures include land treatment, a multiple-purpose flood water retarding and fish and wildlife structure, channel enlargement, and an enlarged floodwater conduit under the center of Walpole. The project will provide an estimated 99 percent reduction in average annual floodwater damages on Diamond Brook. A 17-acre pool which will support a warm water fishery and wetland wildlife will be provided by the multiple-purpose dam. Sponsors of the project are the town of Walpole and the Norfolk Conservation District.</p> <p>The Weweantic River Watershed was the subject of a Reconnaissance Investigation Report in 1971. Primary watershed problems are related to water management for efficient production of cranberries. Floodwater problems in some years are contrasted with a lack of water for irrigating and water-harvesting in other years. The Reconnaissance Report concluded that a PL-566 project could be effective in providing flood protection as well as water storage for cranberry culture. Local participation in the project was contingent upon creation of a watershed association with powers to tax growers, acquire land rights, and manage water resources. Local support for the project and the watershed association was not forthcoming and planning for the project is in an inactive status.</p>

EXISTING PROGRAMS

Subject	Agency	Law or Program
Flooding cont.	U.S. Soil Conservation Service, state and local governments cont.	The Ten Mile Watershed in northwest Bristol County was approved for planning assistance in 1973. Flooding is a major problem in the downtown areas of Attleboro and North Attleborough. Detailed studies of hydrology and hydraulics are now underway in conjunction with Flood Insurance Studies in Attleboro, North Attleborough, and Seekonk.
	Farmers Home Administration, PL-566, local sponsors	Watershed Protection and Flood Prevention Loans - These loans provide assistance to local PL-566 sponsors to provide the local cost of improvements for flood prevention, irrigation, drainage, water quality management, sedimentation control, fish and wildlife development, public water-based recreation, and water storage and related costs. Applicants must have authority under state law to obtain, give security for and raise revenue to repay the loan and operate and maintain the facilities to be financed. The total amount of loans outstanding in any one watershed is limited to \$5,000,000.
	U.S. Department of HUD and municipalities	National Flood Insurance Program - As of July 1977 all but eight towns in the region had joined the National Flood Insurance Program, and property owners can now purchase low cost flood insurance protection. In return for this federally-subsidized insurance, the towns are required to consider flood hazards before issuing building permits, subdivision approvals, or zoning variances. After detailed hydrologic and hydraulic studies are made, HUD will issue flood zone maps which accurately delineate the flood hazard area and depth of flooding. Local governments must then require all new construction be above the 100-year flood elevation. Most financial institutions must require that flood insurance be purchased on any property within the flood hazard zone on which mortgages are accepted. As a condition of participation in the National Flood Insurance Program, a community must adopt flood plain management regulations meeting minimum standards published by the Federal Insurance Administration.
		A community must: (1) require building permits for all new construction and substantial improvements and (2) review the permit to assure that sites are reasonable free from flooding. For its flood prone areas, the community must also require: (1) proper anchoring of structures, (2) the use of construction materials and methods that will minimize flood damage, (3) adequate drainage for new subdivisions, and (4) that new or replacement utility systems be located and designed to preclude flood loss.
Erosion and Sediment	U.S. Soil Conservation Service, Conservation Districts, landowners	Conservation Operations Program - Landowners and communities are assisted in their efforts to control erosion and sediment and in other conservation efforts by the Conservation Districts. The districts coordinate assistance from the Soil Conservation Service, the Extension Service, the Massachusetts Division of Forests and Parks in cooperation with the U.S. Forest Service for forestlands, and from other state and federal agencies.

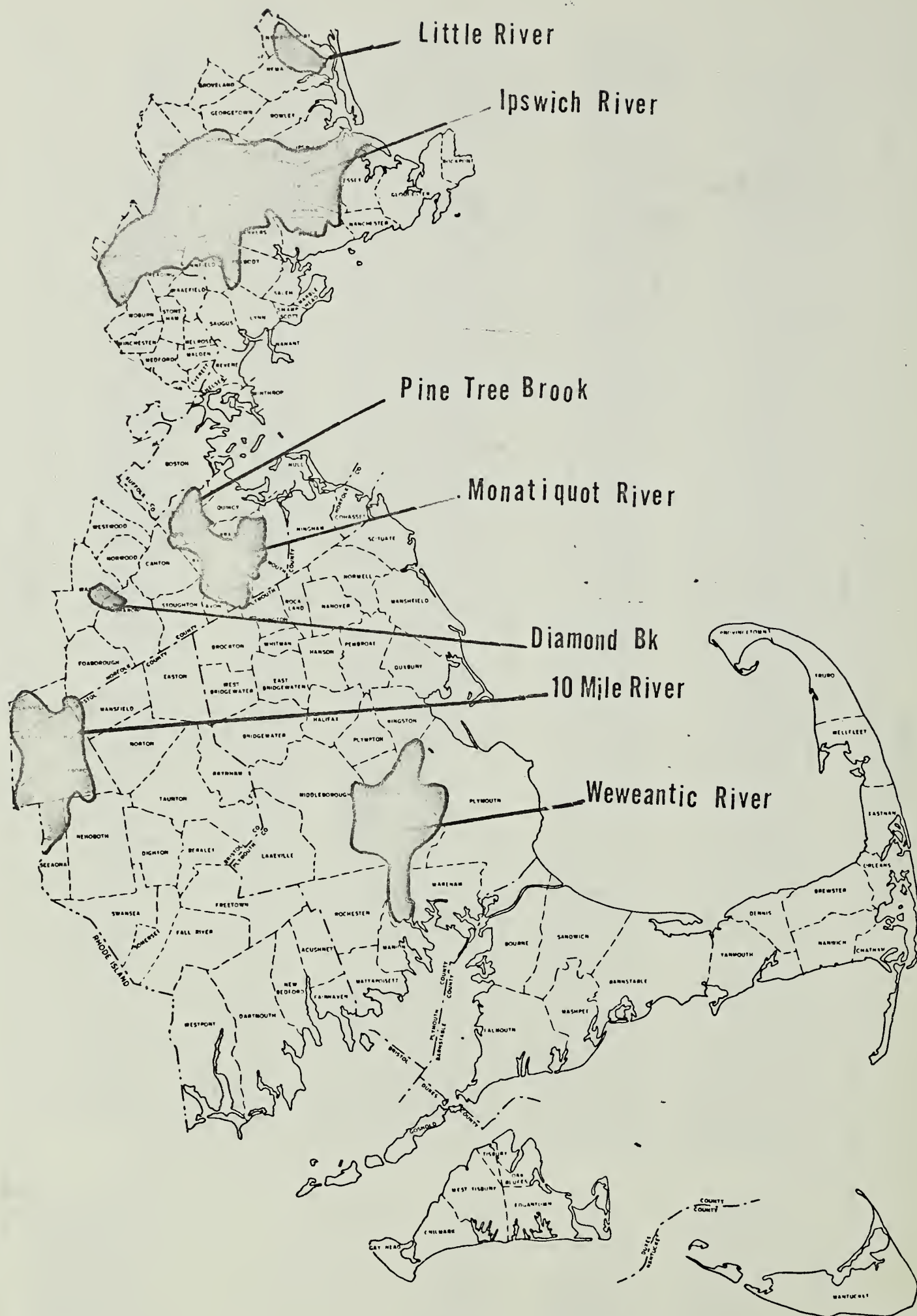


Fig 5. 21
PL-566 WATERSHEDS



Fig 5. 22
REGION COMMUNITIES PARTICIPATING IN
NATIONAL FLOOD INSURANCE PROGRAM

EXISTING PROGRAMS

Subject	Agency	Law or Program
Wetlands	Mass. Department of Environmental Management, Department of Environmental Quality Engineering	<p>Massachusetts General Laws, Chapter 131, Section 40 - The "Hatch Act" passed by the Massachusetts General Court in 1965, attempted to control the alteration of the wetlands. This act has been modified several times by the General Court. The comparable legislation in force today is Chapter 131, Section 40 of the General Laws as amended by Chapter 818 of the Acts of 1974 and Chapter 363 and 334 of the Acts of 1975. This act controls, but does not ban development on wetlands. The law requires that any person or governmental agency intending to remove, fill, dredge, or alter a wetland must insure, by following various procedural and technical steps, that the activity will have no adverse effect on water supplies, flood prevention, pollution prevention, or fisheries protection. In effect the act requires an owner desiring to develop his wetlands do so in accord with public interest and safety.</p> <p>Chapter 131, Section 40, now called the <u>Wetlands Protection Act</u> is administered by town or city conservation commissions or the city mayor or town selectmen in communities without conservation commissions. Appeals from local decisions go first to the Massachusetts Department of Environmental Quality Engineering and, if unresolved at that level the courts become the final arbitrators.</p> <p>Massachusetts General Laws, Chapter 131, Section 40A - The <u>Inland Wetlands Restriction Act</u> allows the Massachusetts Department of Environmental Management to place restrictions on the use of inland wetlands. The Act allows the Commissioner of the Department of Environmental Management to regulate, restrict, or prohibit dredging, filling, removing, or otherwise altering or polluting inland wetlands. Restrictions under this Act have been imposed in several communities in the Coastal Region. To reach this final stage, inland wetlands have to be mapped, and all assessed owners of land within these designated wetlands, must be notified. A public hearing is then held in the community or watershed area. After the public hearing, the town selectmen or city council have to approve the restriction orders in their community. If the community officials fail to approve, the commissioner may override their decision after a six-month waiting period. Redress for unsatisfied landowners is through the courts.</p> <p>Massachusetts General Laws, Chapter 130, Section 105 - A similar program to the Inland Wetlands Restriction Act is available to protect saltwater wetlands. Progress in implementing the saltwater wetlands restriction program has been more dramatic than the inland restriction program. Nearly 18,500 acres of saltwater wetlands have deed restrictions filed. Status of the inland and saltwater restriction program is indicated in Figure 5.23.</p>
Mass. Division of Fisheries and Wildlife, Mass. Division of Forests and Parks		<p>Massachusetts state agencies, in particular, the Division of Forests and Parks and the Division of Fisheries and Wildlife have active land acquisition programs. In addition, the Division of Fisheries and Wildlife has given emphasis to wetlands acquisition to permanently protect wetlands having primary significance to fish and wildlife. Major land acquisitions have been made in the Hockamock Swamp in the Bridgewater and Easton, as well as the Parker River Area on the North Shore.</p>

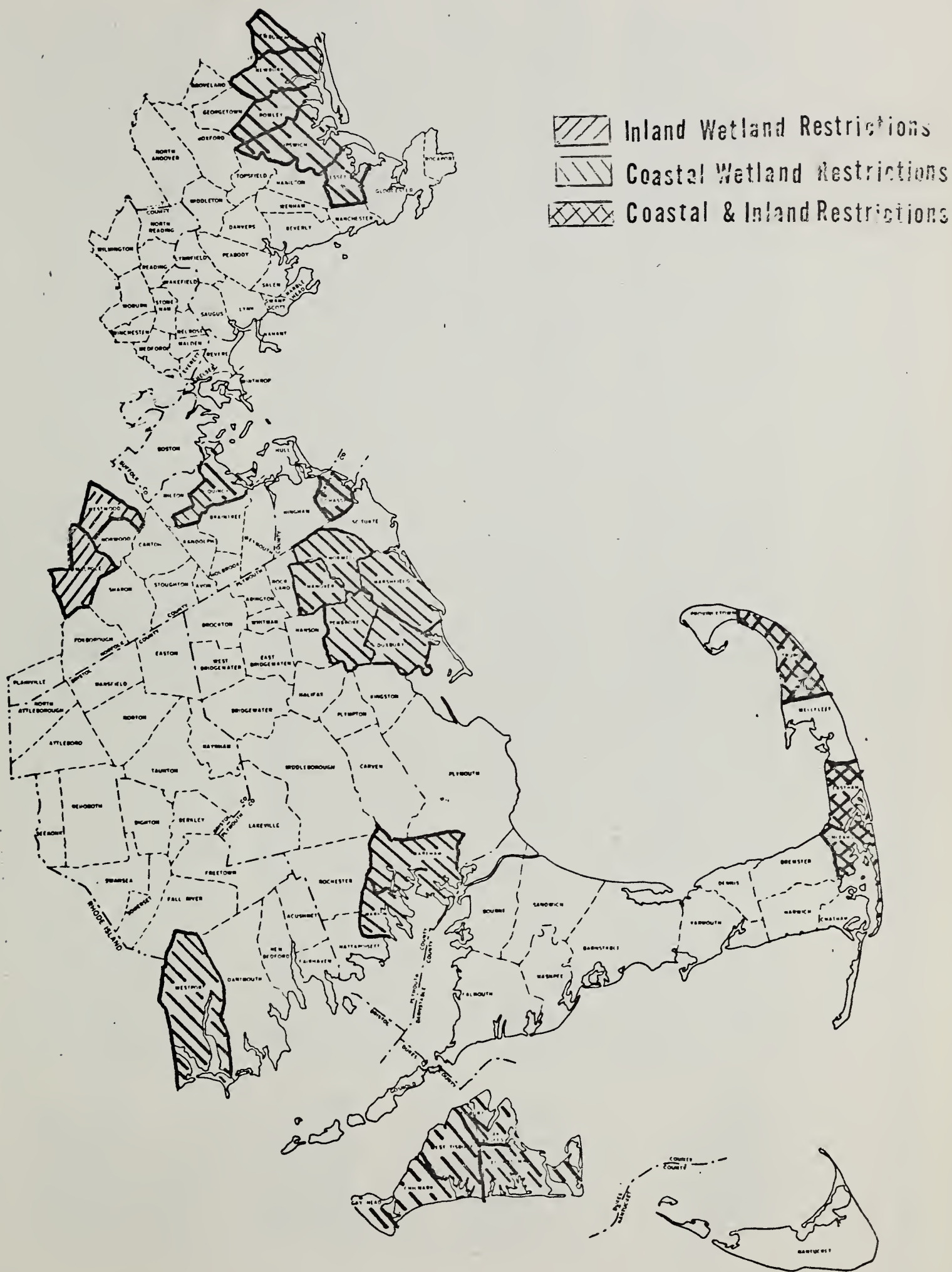


FIG 5.23.
STATUS of WETLANDS RESTRICTION PROGRAMS

EXISTING PROGRAMS

Subject	Agency	Law or Program
Wetlands	Municipalities	Many communities in the region have embarked on conservation area plans which attempt to preserve and enhance the natural resources, and especially the water resources, within the community. Usually this effort is spearheaded by city or town conservation commissions which are authorized to prepare conservation and outdoor recreation plans, acquire open space, land and water areas, prepare and maintain open space areas, and advise local officials on matters relating to conservation subjects.
	Mass. Division of Conservation Services, municipalities, U.S. Bureau of Outdoor Recreation	Federal and state cost sharing funds are available to the cities and towns for use in purchasing conservation open space and recreation areas. The Division of Conservation Services administers the Massachusetts Self-Help Act (General Law, Chapter 40, Section 8C) and administers or coordinates the Land and Water Conservation Program of the Bureau of Outdoor Recreation, the U.S. Department of the Interior, within Massachusetts.
	U.S. Department of HUD, municipalities	In addition to acquisition programs, communities can adopt flood plain zoning ordinances to regulate the use of their wetlands and flood prone area. Restrictions imposed by the National Flood Insurance Program also tend to restrict wetland flood plain development. See the Flooding Section for more details on the National Flood Insurance Program.
	Interested Groups	The Massachusetts Audubon Society, Trustees of Reservations and other similar organizations assist individuals and municipalities in protecting the region's wetlands and other natural resources. These groups engage in various activities including environmental education; acquisition of wetlands, flood plain and other important natural resource areas; wildlife sanctuary and reservation management; and assistance to the region's cities and towns in their respective wetland and other resource programs.
Water Quality	Environmental Protection Agency, Mass. Division of Pollution Control, Mass. Division of Environmental Health, municipalities, industries	Restoration and maintenance of water quality has been the result of a combined effort by the federal, state, and local governments; and private industry. The primary federal agency concerned with water quality is the Environmental Protection Agency. The Massachusetts Department of Environmental Quality Engineering is the lead state agency. Important divisions include the Division of Water Pollution Control and the Division of Environmental Health.

EXISTING PROGRAMS

Subject	Agency	Law or Program
Water Supply	U.S. Dept. of Commerce municipalities	<p>Grants and Loans for Public Works and Development Facilities - This program provides grants of up to 50 percent of the development cost for such public facilities as water and sewer systems, and flood control projects. Jurisdictions designated as redevelopment areas may qualify for grants and loans. These areas may be counties, labor areas, or larger cities characterized by high unemployment or low family income. Severely depressed areas that cannot match federal funds may receive supplementary grants to bring the federal contribution up to 80 percent of the project cost.</p> <p>Loans are also available for public works and development facility projects. These loans may pay the full cost of a project and may run for as long as 40 years, the interest being determined by government borrowing costs. A community that is unable to raise its share of the eligible project cost may receive a grant for 50 percent or more of the project and a federal loan for the remainder of the cost.</p> <p>Water Favorability Studies - Under General Laws Chapter 21, Section 9, this program provides for studies of water favorability in areas of the Commonwealth where there may be a need for such a determination.</p> <p>Upon application of a county, conservation district or upon joint application by two or more municipalities, fire districts or water districts or regional district planning commissions, the Water Resources Commission may contract with any agency of the United States or with private firms to conduct water favorability studies within the jurisdictions indicated in the application. The applicants must provide one-half of the nonfederal cost, and special funding must be provided by legislation for the remainder.</p>
	Mass. Water Resources Commission, municipalities, other units of government	<p>Massachusetts Conservation "Self-Help" Act (G.L. Chapter 132A, Section 11 as amended) - The Massachusetts "Self-Help" Program makes funds available to communities for acquiring conservation-recreation lands. Improvements on land acquired with the help of the Self-Help Program, may include such things as informal playfields, trails, access roads, comfort stations, <u>water impoundments</u>, or <u>wells</u> and campsites.</p> <p>Reimbursements are available only to those municipalities which have established conservation commissions by accepting the provisions of Chapter 40, Section 8C of the General Laws. In addition, a Natural Resource Open Space-Recreation Plan must be filed with the Division of Conservation Services. The land must be controlled by the Conservation Commission after purchase by the community and accessible to any resident of the Commonwealth.</p> <p>An approved project may receive up to 50 percent of the cost of acquisition. If the community is also receiving federal funding assistance under a federal program, the addition of Self-Help funds may involve reimbursement of up to 75 percent of the total cost of the project.</p>
	Environmental Protection Agency, municipalities	<p>Drinking Water Supply-Technical Assistance - Under provisions of the Public Health Service Act (PL 93-523, as amended) the Environmental Protection Agency assists state and local water supply regulatory agencies and public water supply regulatory agencies and public water supply operators and officials to assure that water supply systems serving the public meet minimum National standards for the protection of public health.</p>

EXISTING PROGRAMS

Subject	Agency	Law or Program
Water Supply	Farmers Home Administration, municipalities	Water and Waste Disposal Systems for Rural Communities - These loans and grants may be used for the installation, repair, improvement, or expansion of a rural water system including distribution lines, wells and pumping facilities. Installation, repair or improvement of a rural waste disposal system are also included. Loans may not exceed \$20,000,000. Grants are limited to \$1,000,000.
Recreation	Farmers Home Administration, landowners	Recreation Facility Loans - These loans are intended to assist farm owners to convert all or portions of their farms to income-producing outdoor recreational enterprises to supplement farm income. Funds may be used to: (1) develop land and water resources, (2) repair and construct buildings, (3) purchase land, equipment, livestock, and related recreation items. Recreation enterprises that may be financed include: campgrounds, horseback riding stables, swimming facilities, shooting preserves, nature trails, and lakes and ponds for boating and fishing. Loans cannot exceed \$100,000.
	Landowners	Massachusetts General Laws, Chapter 27, Section 17C - The act limits the liability of landowners who allow recreational use of their property by the public. The obvious purpose of the act is to eliminate the liability that serves as a deterrent to providing recreational opportunities and which encourages the posting of land against trespass.
	U.S. Forest Service, Mass. Division of Forest and Parks, landowners	Recreation Systems of the Forest Service Renewable Resources Program assists landowners to provide forestland recreation opportunities. See the Land Use - Forestland Section for more details on the Renewable Resources Program.
	Mass. Department of Environmental Management	An Act to Protect Scenic and Recreational Rivers and Streams - This act authorizes the Commissioner of Environmental Management to adopt, amend, or repeal orders regulating or prohibiting dredging, filling or altering scenic and recreational rivers and streams. A Pilot Program under this act is being developed for the North River.
	Mass. Division of Conservation Services, municipalities, U.S. Bureau of Outdoor Recreation	Self-Help Funds, and Federal Land and Water Conservation Program - Chapter 132A, Section 11 of the General Laws assists conservation commissions in acquiring land for conservation and developing outdoor facilities. The Land and Water Conservation Fund also provides cost sharing assistance to finance recreation and open space programs.

CHAPTER 6 - FUTURE-WITHOUT-PLAN CONDITION

6.1 DEFINITION AND USE

The Principles and Standards for Planning include a major step to "evaluate resource capabilities and expected conditions without any plan." This involves an appraisal of future economic and environmental conditions expected without a plan, so that these conditions may be compared with those desired by people for the planning area.

Thus, for a selected future date, projections will be made which reflect the inventory and capabilities of the natural resources, the trends which are likely to continue into the future, and the effects of any authorized projects which may alter conditions in the region. The "without-plan" portion of the title implies that the future conditions are to be projected without consideration of any projects which may be in planning stages. This restraint makes it possible to project future conditions which could be expected in the absence of any new programs or projects. Obviously, it makes little sense to embark on an elaborate planning process followed by detailed implementation schemes, if existing authorized projects combined with expected changes will meet the projected demands in a resource area.

The Massachusetts Water Resources Study is concerned with projecting future conditions to the year 1990.

6.2 IMPLICATIONS OF ECONOMIC AND SOCIAL PROJECTIONS TO ENVIRONMENTAL CONSIDERATIONS

As Chapter 4 pointed out, 1990 population projections show an increase of 14 percent (with seasonal population included, 27 percent). Economic activity is also projected to increase, especially service-related enterprises. The potential impact on the environmental quality in the region need not be adverse. Since service-related activities are expected to grow the most (especially relative to manufacturing), environmental impacts are expected to be less adverse. As mentioned previously, the SENE report concluded that projected increases in population and economic activity would not be limited by the region's water and related land resource base, if proper land use guidance were implemented. Given the present array of restrictive land use legislation, plus legislation providing state funding for purchase of development rights, it would appear that adverse environmental impacts will be minimal. Of course, this presupposes that present federal and state environmental laws will not be changed significantly.

6.3 DESCRIPTION OF FUTURE-WITHOUT-PLAN CONDITION

A. Agricultural Land

As noted in Chapter 5, existing land use laws and regulations have been incorporated in the projections (Chapter 4). The statutes that appear

to be the most effective are those that have preservation as their primary objective. This explains, in part, why wetland projections show a small decline relative to the historical trends. Agriculturally related land use laws seem to have little effect on the losses of such land; thus, the historical trend was adjusted only to weigh the recent trends more heavily than the earlier trends. It should be noted that, if current trends continue, the region will continue to lose agricultural land.

With respect to stated public policies and goals, especially regarding agricultural preservation and proper siting of future developments, the future is cloudy, at best. Subdivision control statutes are limited, since approval is not required if such developments occur along existing public roads. Unless additional controls are incorporated, land use guidance will not be forthcoming and, thus, there is some possibility that the resource base and the environment may be adversely effected. Without such guidance, review, or approval procedures, impacts of development will remain somewhat indeterminate.

In December of 1977, the General Court of Massachusetts enacted legislation which would provide \$5,000,000 to support a pilot development rights program wherein said rights are purchased from private land owners. The impact upon agricultural land preservation could be significant. For example, ownership costs (taxes) would be lower because assessments would be based upon agricultural production value rather than market value for developable land. Since development would not

be permitted, farmland would therefore be less costly to purchase which may result in lessening the barriers to entry.

B. Forestland

To determine the future-without-plan condition, it was assumed that forestland will continue to decrease at the rate of approximately 2,700 acres per year, and that forest management efforts will continue at approximately 1976 levels. Presently, an estimated 181,000 acres are assumed to be under some type of forest management. .

Wood Products--Future urban development will have two effects on wood product production. It will decrease the area available for wood production, and it will decrease the average productivity of the region. Sites that are the best for growing trees are among the best for development. These sites will be among the first to be lost to urban expansion and the future productivity of the region will decrease. Only 19 percent of the trees removed in land clearing operations are utilized for forest products and fuelwood. So, land clearing does not contribute significantly to wood product production in the region.

Given the present support level of programs to provide incentives and to educate landowners on forest management, many will continue to let their trees grow unmanaged. Landowner attitudes will discourage new wood-using industries from coming into the region, and there will continue to be a lack of a market for low quality products.

Fuel wood harvesting will increase because of the energy crisis, but this increase could be offset by the decrease in forestland area.

Future wood product production should remain constant or decrease slightly, given the above assumptions. The harvest will remain at about 2 million cubic feet per year, which will result in the disturbance of 7,600 acres of forest land annually.

Water--As long as land in forest cover receives proper management, it will continue to produce sediment-free water. Forestland will remain the dominant land use in the region; therefore, the forest resource will continue to supply a good quantity of high quality water.

Forage--Grazing of livestock on forestland is not a major use now, nor will it become a major use in the future.

Wildlife--The amount and kind of wildlife available in an area depends on the habitat in the area. The majority of the land area is forested, and there are many wetlands to provide diversity needed for good habitat. This is expected to continue into the future.

With the small amount of harvesting taking place, the forests will mature and this will change the kind of wildlife found in the area. As one stage of forest succession goes to another, the animal community associated with the first also gives way to a new community. Even though wild-

life will remain in the region, access to the wildlife for both consumptive and nonconsumptive uses will continue to be a problem. As the area becomes more urban and ownerships become smaller, there will be more posting of land.

Recreation--Future recreation needs will not be fully met through the year 1990. The forestland has the physical capacity to support the development of almost any required number of campsites, picnic areas, and trails. The problem will continue to be one of public access and an insufficient number of developed facilities: (See Table 7.4)

C. Inland Flooding

As a result of the National Flood Insurance Program, many communities in the region are adopting land use regulations which will severely restrict the development of flood prone areas. Flood plain development in towns which are not enrolled in the Flood Insurance Program will be limited by the unavailability of federally supervised mortgage money in flood prone areas. In addition, communities are becoming more cognizant of the importance of flood plain management to discourage improper land use.

As a consequence of the situation stated above, inland flood damage potential in most of the Coastal Region is not expected to significantly

increase by 1990. Changes could occur in individual subwatersheds, if unexpected industrial or commercial development were to occur in the old mill buildings which are located along the region's rivers. Inflation will, of course, increase the total dollar damage potential, but the physical damage is expected to remain essentially unchanged.

There are two exceptions to this "future-without" plan condition. The first is the Diamond Brook Watershed located in Walpole, Massachusetts (subwatershed NE-18). As indicated in Chapter 5, Diamond Brook Watershed has been approved for construction of a multiple-purpose floodwater retarding and fish and wildlife structure, channel enlargement, and an enlarged floodwater conduit under the center of Walpole. Construction of this project under PL-566 will significantly reduce flood damage potential in the Diamond Brook Watershed.

The Corps of Engineers has an authorized project which will significantly reduce flood damage on Furnace Brook (NE-22) in Quincy by the installation of a system of new and enlarged floodwater conduits to convey flood flows. Channel modifications and installation of greatly enlarged conduits are planned.

Flood damages anticipated in 1990 are indicated in Table 6.1.

TABLE 6.1 - PROJECTED 1990 FLOOD DAMAGES ^{1/}

Subwatershed	100-Year Flood Damage	Average Annual Damage
	-Parker River Watershed-	
PA-2 (Little River)		2/
PA-3 (Parker River)		2/
	-Ipswich River Watershed-	
IP-4 (Ipswich River)	2,020,000	121,200
	-North Shore Watersheds-	
NS-5 (Annisquam River)	115,800	20,900
NS-6 (Danvers River)	517,800	93,100
NS-7 (Saugus River)	1,635,000	179,800
NS-8 (Mystic River)	108,000	19,400
	-Neponset River Watershed-	
NE-17 (Neponset River)		2/
NE-18 (Diamond-Traphole Brooks)	647,000	79,300
NE-19 (Neponset River)	73,000	8,100
NE-20 (Neponset River)	600,000	36,000
NE-21 (Pine Tree Brook)		2/
NE-22 (Neponset River)	600,000	66,000
	-South Shore Watersheds-	
SS-23 (Town River)	4,385,000	482,500
SS-24 (Monatiquot River)	355,200	21,400
SS-25 (Smelt Brook)		2/
SS-26 (Weir River)		2/
SS-27 (North River)		2/
SS-28 (South River)		2/
SS-29 (Jones River)		2/
SS-30 (Eel River)		2/
SS-31 (Cape Cod Canal)		2/
	-Taunton River Watershed-	
TA-47 (Town River)		2/
TA-48 (Matfield River)	437,400	26,300
TA-49 (Shumatuscacant River)		2/
TA-50 (Winnetuxet River)		2/
TA-51 (Taunton River)		2/
TA-52 (Taunton River)	182,400	10,900
TA-53 (Nemasket River)		2/
TA-54 (Mill River)	122,600	7,300
TA-55 (Rumford River)		2/
TA-56 (Threemile River)	835,800	50,200
TA-57 (Taunton River)		2/
TA-58 (Assonet River)		2/
	-Narragansett Bay Watersheds-	
NB-59 (Palmer River)		2/
NB-60 (Ten Mile River)	2,049,600	367,900
NB-71 (Quequechan River)		2/
NB-72 (Cole River)		2/
	-Buzzards Bay Watersheds-	
BB-41 (Agawam River)		2/
BB-42 (Weweantic River)	488,000	88,000
BB-43 (Crane Brook)		3/
BB-44 (Mattapoissett River)		2/
BB-45 (Acushnet River)	211,800	38,200
BB-76 (West River)		2/
	-Cape Cod and Islands-	
All Cape Cod and Islands subwatersheds have less than \$5,000 in average annual damage.		

^{1/} Price Base 1976.^{2/} Average Annual Damage less than \$5,000.^{3/} Crane Brook damage figures have been included with those for the Weweantic River.

D. Wetlands

The future status of wetlands loss in the region will in large measure be determined by the effectiveness of the Wetlands Protection Act and the Inland and Coastal Wetlands Restriction Acts. The ownership and zoning of the wetlands will also be a factor in determining the potential for loss of wetlands.

Wetlands Protection Act applications have been reviewed for a sample of 85 communities in the state. The sample indicates that in 1976, nearly 290 acres of the 80,800-acres of inland wetlands in the sampled communities had received alteration permits. An analysis of building permit data for the last ten years showed that construction expenditures for 1976 were being made at a rate nearly 15 percent above the 10-year average. In view of this, the 1976 loss of inland wetlands figure, approximately 0.4 percent per year, is considered appropriate for use here.

Publicly owned wetlands are in less danger of being lost to development than privately owned areas. Surveys of the inland wetland areas indicated over 14 percent were owned by government or some quasi-public body, such as the Massachusetts Audubon Society or Trustees of Reservations. Zoning can also affect the rate of wetland loss. Conservation and flood plain zoning of wetlands will tend to preserve wetland areas, while industrial or commercial zoning indicates a potential danger to the wetlands. Nearly 46,000 acres or 29 percent of the inland wetlands were placed under special regulations such as flood plain, wetland, and conservation zoning.

Considering historical wetland losses, adjusted for variations in construction activity and factoring in the effects of public ownership and protective zoning, indicates a projected loss for inland wetlands of about 8,900 acres between 1977 and 1990.

Loss rates for saltwater wetlands were not projected, but they are assumed to be very low. Saltwater wetlands are also within the 100-year tidal flood plain affording protection through the Federal Flood Insurance Program which restricts building in 100-year flood zones. Since nearly 45 percent of the saltwater wetlands are already protected by the Coastal Wetlands Restriction Program, future losses are expected to be minimal.

Discussions with personnel involved with the inland and saltwater wetland restriction programs indicated that, if the programs continue at their present rate, restrictions will be imposed by 1990 on over 26,000 acres of inland wetlands, and 41,000 acres of saltwater wetlands in the region.

TABLE 6.2 - WETLAND STATUS AND PROJECTIONS

Present Status	
Total Inland Wetlands (1977)	159,510 acres
1. Wetlands in public or quasi-public ownership (22,740 acres)	
2. Wetlands in areas under special regulations (Conservation Zoning) (45,980 acres)	
3. Privately owned wetlands restricted under General Laws, Chapter 131, Section 40A (2,350 acres)	
"Protected" wetlands (1, 2, and 3)	<u>71,070</u> acres
Wetlands protected only by General Laws, Chapter 131, Section 40, in 1977	88,440 acres
Projections (1977 to 1990)	
4. Additional public acquisition (20,800 acres)	
5. Additional Chapter 131, Section 40A restrictions (23,760 acres)	
6. Projected development loss (8,930 acres)	
Additional "protected wetlands" (4, 5, and 6)	<u>53,490</u> acres
Wetlands protected only by General Laws, Chapter 131, Section 40, in 1990	34,950 acres

Twenty-four cities and towns have had their coastal wetlands and tidal flats restricted under Massachusetts General Laws, Chapter 130, Section 105, the Coastal Wetlands Restriction Act. It is expected that the program will be

implemented as vigorously as it has been in the past, and that the remaining 44 towns with coastal wetlands will be in the restriction program by 1990.

E. Erosion and Sediment

Erosion problems resulting on forestland being harvested, roadbanks, unpaved roads, gravel pits, and streambanks are expected to be managed and controlled by existing programs and services. Existing programs, as presently administered, will not be able to bring erosion losses to an acceptable level on cultivated farmland, construction areas, or related critical erosion areas, such as road cuts with unstable slopes, sand dunes, and utility rights-of-way.

Without increased funding or emphasis, the Conservation Operations Program of the Soil Conservation Service is expected to be able to meet approximately 35 percent of the existing land treatment needs on cultivated cropland by 1990.

Erosion losses on the 9,500-acres of land being converted to urban uses is expected to be more than 340,000 tons per year without action to regulate and modify developer practices.

There are over 150 identified critical erosion areas in the region which will, in all likelihood, remain problem areas unless some definite program action is undertaken.

F. Water Quality

The Federal Water Pollution Control Act Amendments of 1972 has as an objective the restoration and maintenance of the chemical, physical and biological integrity of the nation's waters. To achieve this objective, two major goals were established: 1. To attain swimmable-fishable waters by 1983, and 2. to achieve zero discharge of pollutants by 1985.

Point sources of pollution have been the major emphasis of the clean-up efforts to date. Hundreds of millions of dollars have been, and will continue to be, spent to meet the enormous costs involved in constructing and operating wastewater treatment plants.

Although the objective of the 1972 Amendments to the Water Pollution Control Act will be difficult to achieve and expensive, public sentiment for clean water is overwhelming. Major pollution problems still exist in the Charles River, Taunton River, and New Bedford Harbor. These are areas close to heavy concentrations of population and, thus, in areas where the demand for clean water for other uses is also great.

The SENE study found, and we agree, that the "existing programs, authorities, and institutions are good enough" to meet the water quality goals. "The basic need is for better use of these (existing) tools, not more tools."

Alternatives for meeting the remaining water quality problems are presented in detail in the SENE study and in the Water Quality Management plans published by the Massachusetts Division of Water Pollution Control, and we see no purpose in repeating the information. The subject of water quality will not be carried further in this report as an individual study concern, but will only be addressed when it overlaps another concern, such as land use, or erosion and sediment. These areas of overlap will be restricted to the water quality effects of nonpoint pollution sources and alternatives for minimizing the problem.

The Water Quality Management Plans being prepared under Section "208" of the Federal Water Pollution Control Act should indicate what is needed to meet water quality goals in the region. The magnitude and seriousness of nonpoint pollution sources should be more clearly understood after completion of the plans. Measures to alleviate nonpoint problems will follow the evaluation of problem extent.

G. Water Supply

The Southeastern New England (SENE) Study and the Northeastern United States Water Supply (NEWS) Study both concluded that diversion of the Connecticut River water would be needed to meet the 1990 needs of the Metropolitan District Commission communities. Proposals have also been presented to alleviate some of the need for diversion by reducing excessive leakage in distribution systems, exploring for ground water

resources in the member communities, and by possible additional utilization of the Sudbury River as a water source. The SENE Study concluded that "while several water supply alternatives may be potentially important to the MDC's future supplies, and while water conservation measures can result in significant savings, neither the individual alternatives nor combination of them has the potential to fully meet the MDC's projected short-range water supply needs of 77 million gallons per day." In contrast, the Connecticut River Diversion would supply the MDC's needs through the late 1980s.

The Massachusetts Water Resources Study agrees with the findings of the SENE Study in regard to water supply for the MDC communities. As a result, this study assumed that all of the communities currently being supplied or expected to be supplied by the MDC would be able to meet 1990 demands, by development of the Connecticut River Diversion or by some other supply development or a combination of water conservation and additional supply.

Communities in the category include:

<u>Northeast</u>	<u>Southeast</u>
Boston	Quincy
Canton	Stoughton
Chelsea	
Everett	
Malden	
Marblehead	
Medford	
Melrose	
Milton	
Nahant	
Peabody	
Revere	
Saugus	
Stoneham	
Swampscott	
Wakefield	
Winchester	
Winthrop	
Woburn	

Some of the communities in the region presently have sufficient developed municipal water supplies to enable them to meet 1990 demands. These fortunate communities include:

<u>Northeast</u>	<u>Southeast</u>	<u>Cape Cod & Islands</u>
Danvers/Middleton	Fairhaven	Bourne
Essex	Fall River	Falmouth
Lynn*	Hanover	Harwich
Lynnfield	Marion	Edgartown
Manchester	Mattapoisett	Gosnold
Newburyport*	Seekonk	Nantucket
Rowley	Somerset	Tisbury
Wenham	Swansea	
	Taunton	
	Wareham	
	West Bridgewater	
	Weymouth	

* Increased storage capacity required.

In addition, the towns of Berkley, Carver, Plympton, Rochester, and Gay Head are expected to be able to meet projected 1990 demands with private water supplies.

The communities discussed above appear to be able to meet 1990 demands. The Massachusetts Executive Office of Environmental Affairs has recently developed a "Water Supply Policy Study" for the state. The study utilized available data whenever possible. Data from the recently completed Southeastern New England (SENE) Water and Related Land Resources Study, prepared under the direction of the New England River Basins Commission, has been included to the fullest extent. There is no need to repeat the work of either the SENE, NEWS, or State Water Supply Policy Study in the area of water supply. Therefore, the water supply analysis will not be carried beyond this chapter. Those desiring detailed water supply data are referred to the previously completed studies.

Information concerning potential surface water reservoir sites which appear to be suitable for development as municipal water supply reservoirs is found in Appendix A of this report.

H. Recreation

Recreational planning in Massachusetts is guided by the Statewide Comprehensive Outdoor Recreation Plan (SCORP) which projects demand for recreation to the year 2000. Supply figures, however, are based upon

currently available facilities. Comparison of 1990 demand figures with present supply indicates a huge unmet demand in all of the water-based or water-related activities (swimming, camping, picnicking, canoeing, sailing, and hiking), except swimming. This unmet demand is so large that planned state programs will not satisfy the need. Alternatives will be presented in a later chapter which offer potential to meet some, but nowhere near all of the potential need.

Of the 318-natural areas identified in the 1974 Massachusetts Landscape and Natural Areas Survey, 172 are now owned by public or private conservation organizations or institutions. By 1990, it is expected that an additional 40 sites will be acquired or protected, making a total of 212 sites in a protected status.

Historical and cultural sites in the region are more than adequately identified and protected by ongoing efforts of federal, state, and local governments and private individuals and organizations.

Streams in the Coastal Region do not appear to meet the criteria of the Federal National Wild and Scenic River Act of 1968. The SCORP report indicated four rivers with potential for protection under the Massachusetts Scenic and Recreational Rivers Act. Because of uncertainty about implementation of the program, we have assumed that no rivers will be protected under the act for the "future-without project" condition.

Development of public access to ponds and lakes in the region should be increasing in the future, although the magnitude of this increase is difficult to quantify. Conservation commissions are actively seeking to acquire prime areas, many of which are wetlands or include fresh open water. Appendix D indicates the access status of public lakes, ponds, and reservoirs. There have been suggestions made that the Public Access Board should be making a greater effort to acquire formal public access to the Great Ponds of the state. The Wetlands Protection Act, Chapter 131, Section 40, should be effective in preventing loss or harmful alteration of fresh open water areas. The Act is administered by local conservation commissions that are becoming more and more sophisticated and careful in issuing alteration permits.

I. Fish and Wildlife

According to the Division of Fisheries and Wildlife, demand for fish and wildlife recreational opportunities over the next 25 years will increase but to an unknown degree dependent upon various positive and negative factors which are impossible to predict. Participation in hunting and fishing, however, is expected to increase at an average rate of one-half percent per year. Participation in nonconsumptive fish and wildlife recreational activities will likely increase under the stimulus of a state "non-game" program when such is established, and continued publicity involving rare and endangered species.

It is anticipated that the larger game mammals, waterfowl, raptors, upland game, and songbirds will continue to receive major public attention and support. Reptiles, amphibians, rodents, various less visible species, and those animals viewed as pests are expected to attract only minor attention.

CHAPTER 7 - NEEDS

7.1 INTRODUCTION

Needs may be defined as the unmet demand which will not be satisfied by existing resource management or by implementation of authorized plans or projects. The quantification of needs stems from the evaluation of resource capabilities and expected conditions without a plan. In effect, needs indicate the areas where additional planning, authorization, and implementation is needed to meet the desires of society.

7.2 NEEDS

A. Agricultural Land

Table 7.1 summarizes the needs as determined from the future-without-plan condition relative to the stated problems and objectives. The primary need is to maintain or increase agricultural land. As Table 7.1 shows, there are a number of subneeds that must be met in order for the primary need to be satisfied.

An interesting aspect within the land resource area is that, by solving the NED problem, much of the identified EQ problem (loss of open land) is also solved. Thus, the needs for the EQ objective in the land resource area are similar to those of the NED objective. There is some

dichotomy, however, in that one of the objectives is to increase or, at least, maintain agricultural production. But if this is accomplished, the water resource quality may be adversely effected by continuing or increased levels of nonpoint sources of pollution. Thus, as Table 7.1 summarizes, there is a need for an aesthetically pleasing land use mix, and if such a mix is derived from a continuation of agriculture, then there is another need to minimize nonpoint sources of pollution from agriculture.

TABLE 7.1 - AGRICULTURAL LAND USE NEEDS

Primary Objectives	Resource Area	Needs
National Economic Development	Agricultural Land	<ol style="list-style-type: none"> 1. Reverse trend of agricultural land loss. 2. Insure proper land use planning to minimize future development on agricultural land.
Environmental Quality	Open land	<ol style="list-style-type: none"> 1. Locate future developments so as to minimize impacts on environmentally sensitive areas. 2. Preserve open land to contribute to an aesthetically pleasing land use mix. 3. Minimize nonpoint pollution agricultural sources.

One of the most important regional needs is to complete the soil survey. These surveys are extremely useful in providing an inventory of soil types, in providing soil interpretations for guiding certain land uses, and in providing critical area locations.

B. Forestland

By the year 1990, there will be a need for an additional 7.2 million cubic feet of wood products for the region.

The first step in increasing production is to increase the management of public and private forestland for wood products. There will be a need for an increase in forest management for wood products from the present 181,000 acres to 450,000 acres.

Many landowners require incentives to persuade them to manage and not develop their land for other uses. If a landowner is going to manage his land for forest products, he has to see the possibility of selling his products. There is a need to develop diversified markets. To increase management on private forestland, many owners need to be informed on the opportunities and benefits of forest management.

To increase or maintain the environmental quality of the area, there is a need to combine the urban and forest environments in a way that maintains some of the benefits of the forest environment. This can be

accomplished by first informing towns about urban forest management, and, secondly, providing technical assistance to towns to manage their urban forestlands.

Additional needs beyond the scope of the material included in this report are areas of study and measures that would complement and strengthen the forest industry sector. At the present time, the secondary wood-using industries reportedly draw nearly all their requirements for wood from areas outside the state. There is a need to study the structure of these industries with a goal of supplying more of their needs from in-state milling plants.

The urban character of the region with attendant development pressures on forestland indicates a need for study of the cost-benefits of land devoted to forestry purposes versus other land purposes. The urban character of the region also indicates a need for study of the economics of tree growing, harvesting, and milling wood within the context of the region's characteristics.

C. Flooding

One of the objectives of this study of flooding is to develop alternatives to reduce flood damages to an acceptable level. The definition of "acceptable level" is subject to discussion. For purposes of this study, however, total average annual flood damage of less than \$5,000 per sub-watershed was considered an acceptable level. This is roughly equivalent to a 100-year frequency flood causing \$80,000 in damage. Subwatersheds expected to need alternatives to reduce flood damage are indicated in Table 7.2.

TABLE 7.2 - FLOOD DAMAGE REDUCTION NEEDS

Subwatersheds	Description	Average Annual Damage
IP-4	Ipswich River	\$121,200
NS-5	Annisquam River	20,900
NS-6	Danvers River	93,700
NS-7	Saugus River	179,800
NS-8	Mystic River	19,400
NE-18	Diamond - Traphole Brooks	79,300
NE-19	Neponset River	8,700
NE-20	Neponset River	36,000
NE-22	Neponset River	66,000
SS-23	Town River	482,500
SS-24	Monatiquot River	21,400
TA-48	Matfield River	26,300
TA-52	Taunton River	10,900
TA-54	Mill River	7,300
TA-56	Threemile River	50,200
NB-60	Ten Mile River	367,900
BB-42	Weweantic River	88,000
BB-45	Acushnet River	38,200

D. Erosion and Sediment

Major erosion and sediment control needs are concentrated in three areas: construction projects, tilled cropland, and other critical erosion areas.

Areas Undergoing Urban Development (construction sites)

From 1952 to 1972, approximately 7,300 acres of nonurban land were converted to urban use per year in the region. During the construction

period, soils are usually stripped of vegetative cover and are often left in this exposed condition for extended periods of time. The result can be severe erosion on the site and quantities of sediment released downstream. It is expected that 9,500 acres per year will be converted to urban use by 1990. Gross erosion from these areas is expected to exceed 340,000 tons per year.

Tilled Cropland

Erosion rates on approximately 20 percent of the tilled cropland are excessive. The average annual erosion loss from tilled cropland in the region is 4.3 tons per acre, nearly 40 percent greater than the average tolerable loss of 3 tons per acre for most soils. There are also individual farms within the region which have critical erosion problems on cropland which far exceed the average erosion rate. Cropland treatment needs are summarized in Table 7.3.

TABLE 7.3 - LAND TREATMENT NEEDS (1990)

Measure	Acres Needing Treatment
Residue and cover	800
Sod in rotation	370
Strip Cropping	200
Permanent Cover	<u>1,310</u>
Total Cropland Needing Treatment	2,680

Critical Erosion Areas

In addition to these erosion problem areas, the region has some isolated critical erosion areas which are not being stabilized under ongoing programs. These critical areas include road cuts with unstable slopes, blowing and drifting sand from coastal dunes, and blowing sand from utility rights-of-way which have been scarred by off-road recreational vehicles, and blowing dust from gravel pits. Although these critical areas are not regionally significant in terms of total volume of erosion, the erosion and its effects are locally significant and should be minimized.

E. Wetlands

According to the wetlands projections in Chapter 6, by the year 1990, over 8,900 acres of inland wetlands will be lost to urban development. An additional 35,000 acres will be protected only by General Laws, Chapter 131, Section 40, the Wetlands Protection Act.

The needs in the area of inland wetlands can be summarized, as follows:

1. Reduce projected wetland loss;
2. provide additional protection to the 80,930-acres of inland wetlands which are not protected by public ownership or the Wetlands Restriction Act;
3. provide additional public access to inland wetlands for passive recreation.

F. Recreation

Recreation needs are indicated in Table 7.4, abstracted from the SCORP report data.

TABLE 7.4 - RECREATION NEEDS

Activity	1975 Supply (1000 Activity Days)	1990 Demand	Needs
Swimming	51,750	45,298	(surplus)
Camping	1,770	3,269	1,499
Picnicking	1,693	15,573	13,880
Canoeing-Sailing	4,428	6,468	2,040
Hiking	1,223	10,793	9,570

The Needs figures require some explanation. Although there is a surplus of swimming facilities available in the region, the distribution of these facilities is not coincident with population. Hence, though there is a surplus of swimming on Cape Cod and the Islands, there is a need for additional beachfront in the northern part of the region.

The large need for picnicking facilities in reality represents a need for picnic tables. In lieu of formal picnic facilities, much of the demand is now, and will continue to be, met by informal picnic sites; i.e., a blanket under a tree.

Likewise, the need for hiking trails may be met with something less than a formally mapped and labelled "trail." Utility rights-of-way, abandoned railroad rights-of-way, rural highways, and even city streets in an historical area, such as the Coastal Region, can serve to provide an enjoyable hiking experience.

Even with these conditional statements concerning needs, there is a large unmet demand, or need, in all five water-related recreation activities. There is also a need to take steps to implement the provisions of the Massachusetts Scenic and Recreational Rivers Act.

CHAPTER 8 - ALTERNATIVES

8.1 INTRODUCTION

Alternatives designed to meet the needs expressed in Chapter 7 are presented in this chapter for each major study concern. Table 8.4 compares the alternatives with needs and assesses the effectiveness of each alternative. Effects of the alternatives on national economic development, environmental quality, social well-being, and regional development are presented in Table 8.5. Table 8.6 summarizes the potential environmental effects of the alternatives.

8.2 LAND USE ALTERNATIVES

This section addresses the public policy alternatives that are relevant to the problems and needs identified in land use. One alternative is the continuation of present policies. Since such action would not have a positive impact on the problems and needs discussed in this report, the "without plan" alternative is omitted from further discussion.

A. Agricultural Land Use Alternatives

It is apparent, from recent discussions with state officials, that an overriding concern is the preservation or expansion of agricultural land in the hope that production in the agricultural sector may be maintained or increased. Related to this is the desire to maintain a

variety of land uses which will continue to provide a good aesthetic and environmental setting, in terms of wildlife habitat and scenic viewing.

Past measures enacted in most states, including Massachusetts, were based upon regulations (i.e., zoning ordinances) and incentives (i.e., agricultural assessments). Given the continuing trend of declining agricultural land, it is apparent that these approaches have not been effective. Regulations have been ineffective for two reasons: 1. Zoning an area agricultural does not necessarily insure that agriculture will be practical. 2. Those owners whose land is zoned low density have a strong economic incentive to press for zoning variances. Historically, applications for zoning variances are often approved.

The incentive or agricultural assessment approach was aimed at decreasing taxes to agricultural enterprises. Although this measure has made staying in agriculture easier, it has not precluded the selling of agricultural land to nonagricultural users, primarily because the tax penalties assessed on such transactions are small in comparison to the amounts received for those properties. An underlying thought in the preferential assessment approach is that only a little monetary assistance is necessary to keep agricultural firms viable. Little, if any, research has been undertaken to determine exactly how much help is required.

A number of states have recently been considering other means by which agricultural land might be preserved. Vermont and Washington have enacted land sales excise taxes. In Washington, for example, on land sold by an owner of six years or more, no taxes are paid. However, for an owner of less than one year who sells land, the tax amounts to 50 percent of the sales price. Vermont law is similar, though tax percentages may differ somewhat. The main purpose of these laws is to decrease speculative buying of agricultural land with the intent to sell quickly to nonagricultural uses.

A number of states, including Massachusetts, have passed legislation providing for the public purchase of development rights to agricultural land and, thus, precluding other uses. Such a program is a combination of the regulatory and incentive approaches. It is regulatory, in the sense that agricultural areas must be designated for preservation, and it includes incentives, since the income derived from the sale of the development rights can be reinvested in the farm enterprise to increase efficiency and net borrowing power and, thereby, hopefully increasing its competitiveness.

The public investment required in a development rights program is dependent upon the difference in the value of land used for agriculture and the value, if the land were used for development. Thus, in areas that are in close proximity to higher value uses, the public costs per acre in purchasing the development rights would be higher than in areas located further away. After the development rights are purchased, no other uses would be permitted. Such a program has two advantages over those previously mentioned:

1. The sale of development rights will provide compensation to owners of restricted areas.
2. Prospective farmers will require less financial resources to enter farming, since land prices will be based on agricultural earnings, rather than upon potential development values.

Table 8.1 summarizes the component needs of agricultural land and the various alternatives through which such needs may be satisfied.

TABLE 8.1 - SYSTEMS FOR PRESERVING AGRICULTURAL LAND

Component Needs	A Zoning and Preferential Assessment	B Purchase Leaseback	C Development Rights
1. Maintain or increase agricultural protection.	No	Yes	Yes
2. Maintain or increase environmental and aesthetic qualities.	No	Yes	Yes

B. Forestland Use Alternatives

Chapter 7 listed both the NED and EQ needs of the forest resource.

Based on these needs, four alternatives are suggested. Three of the alternatives have several subalternatives which, when combined, make up the major alternative. One or all of the subalternatives can be implemented. The four alternatives are:

1. Increase forestland management by increasing the number of personnel working on state and private land providing technical assistance to landowners.
 - a. Add four technicians and seventeen woods workers on state forestland;
 - b. add a full-time survey crew to locate state forest boundaries;
 - c. add six foresters to provide management assistance to private landowners;
 - d. add four technicians to assist service foresters;
 - e. engage professional forestry consultant firms to accomplish the above, where applicable.
2. Increase incentives to landowners to encourage them to manage their forestland for timber products.
 - a. Increase Forest Incentive Program funding by \$33,000;
 - b. change Chapter 61 of the Massachusetts General Laws (Classification and Taxation of Forestland) by eliminating the ceiling of \$400/acre value on forestland;
 - c. increase Agricultural Stabilization and Conservation funds in counties where land is valued too high for Forest Incentive Program funds;

- d. change liability law to limit landowners' liability for injuries incurred in timber harvesting;
 - e. revise nursery program to provide free trees to landowners.
- 3. Establish a program to increase and diversify the markets for forest products, to encourage the utilization of low quality products, and to provide increased marketing assistance to the existing wood-using industry.
 - a. Hire two utilization foresters to work in the area at the county level;
 - b. encourage the establishment of two plants to utilize low quality products;
 - c. develop a fuel wood management program;
 - d. provide low interest loans for sawmill modernization.
- 4. Establish an information and education program to inform private landowners about the benefits of forestland management.
 - a. Hire four people to conduct an information and education program throughout the region. This should include metropolitan areas where many nonresident forest landowners live.

The EQ needs can also be met with the above alternatives. The information and education program can inform urban as well as rural landowners. The increases in personnel can provide technical assistance needed in the urban areas.

8.3 FLOODING ALTERNATIVES

Flood damages can be minimized by careful planning and implementation of flood plain management techniques. Flood plain management programs should contain regulatory and corrective measures.

Regulatory measures do not prevent flooding but, instead, reduce the threat of damage or loss of life from floods by discouraging development on flood plains. Regulatory measures include flood plain regulations, development policies, land use restrictions, greenbelts or open space, and flood insurance. Tax adjustments and warning signs are related measures.

Corrective measures, while they do not eliminate flooding, can reduce the extent of flooding and resulting damages. These corrective measures are usually physical measures and can include land treatment, floodwater retarding structures, stream improvements, levees or floodwalls, existing reservoir management programs, floodproofing of structures, relocation of buildings or flood plain reclamation, and flood watch and warning systems.

As noted previously, regulation of development on flood plains is expected to effectively limit increases in flood damages. Corrective measures will also be needed to reduce damage to existing development.

Corrective measures, as described below, are usually physical measures that are designed to reduce or control floods and flood damage.

Land Treatment--Vegetative and mechanical land treatment measures can be installed on the uplands to prevent destruction of land by erosion and reduce the movement of damaging amounts of sediment to the streams and flood plains. Agricultural lands and lands in transition from agriculture to urban uses should be protected or maintained by temporary vegetation, mulch, sediment basins, or other measures to reduce and control erosion. Land treatment measures also slow or reduce runoff and peak flood flows from upland areas.

Floodwater Retarding Structures--These structures are earthfill or concrete impoundments that check the uncontrolled flow of floodwater rushing downstream. The structures are located to protect the largest possible area of land subject to flooding, encroach as little as possible on high value lands, and provide a high level of protection to downstream property.

Stream Modifications--Stream channel changes to increase channel capacity to carry floodwater can be made by straightening, deepening, widening, clearing, or by lining the channel so that flooding will be less frequent and severe.

Dikes and Floodwalls--These are earth embankments or concrete walls built along the bank of a stream to confine flood flows to the channel or floodway. Dikes and floodwalls are normally used to provide protection to high value flood prone areas.

Floodproofing of Buildings--Techniques used to make existing buildings, contents, and grounds located in flood hazard areas less vulnerable to flood damage are:

1. Permanent measures built as an integral part of the structure, such as: raising the elevation of the structure, waterproofing of basement and foundation walls, anchorage and reinforcement of floors and walls, and use of water-resistant materials;
2. contingency measures which require action to be taken to make them effective, such as, manually closed sewer valves and removable bulkheads;
3. emergency measures carried out during floods according to prior emergency plans, such as, sandbagging, pumping, and removal of contents to flood-free areas.

Flood Plain Reclamation--This includes the permanent evacuation of developed areas, subject to inundation and the acquisition of lands by purchase, the removal of structures, and the relocation of the population from such areas. Such lands could then be returned to a natural wildlife habitat or used for agriculture, low intensity recreation, or other purposes which would not interfere with flood flows.

Flood Watch and Warning Systems--The National Weather Service of the National Oceanic and Atmospheric Administration issues warnings of potential flood producing storms. Frequently, the flood warnings are preceded by a "severe weather or flood watch." Local programs can also be implemented to give advance warning to flood prone areas of potential or impending flood danger. On small watersheds with considerable swamp storage, staff gages set at key locations could be monitored by local personnel. Monitoring could be accomplished by the use of float-activated electronic warning signals connected to the police or fire department. All warning systems should be coordinated with local Civil Defense disaster plans.

A. Coastal Region Flooding Alternatives

Three combinations of corrective measures were investigated to illustrate the range of possibilities available to reduce existing flood damage. A summary of the combinations, costs, and remaining damages is presented in Table 8.2.

Land treatment, floodwater retarding structures, stream improvements, and dikes and floodwalls were considered as one combination. These structural measures have been the traditional basis of federally-financed, flood control projects. Reduction in flood damage is achieved by reducing runoff and peak flows or by confining flood flows to established channel or floodways.

TABLE 8.2 - SUMMARY OF ALTERNATIVES TO REDUCE FLOOD DAMAGE

Sub-water-shed	1990 Flood Damage 100-Year Average Flood Annual	Structural Alternative				Floodproofing Alternative				"Mixed Alternative"			
		Flood Damage with Project		Project Cost 1/		Flood Damage with Project		Project Cost 1/		Flood Damage with Project		Project Cost 1/	
		100-Year Flood	Average Annual	Total Cost	Average Annual 2/	100-Year Flood	Average Annual	Total Cost	Average Annual 2/	100-Year Flood	Average Annual	Total Cost	Average Annual 2/
IP-4	2,020,600 121,200	725,200	43,600	52,000	3,600	854,800	51,200	47,000	3,900	No reasonable mixed alternative.	No reasonable mixed alternative.	No reasonable mixed alternative.	No reasonable mixed alternative.
NS-5	115,800 20,900	101,400	18,200	23,900	1,600	76,200	13,700	12,800	1,100	76,200	13,700	31,200	2,400
NS-6	517,800 93,100	253,700	45,700	91,500	6,300	222,400	40,100	123,800	10,400	229,200	41,300	106,500	7,900
NS-7	1,635,000 179,800	No reasonably feasible alternative.				No reasonably feasible alternative.				No reasonably feasible alternative.			
NS-8	108,000 19,400	No reasonably feasible alternative.				10,800	1,920	41,600	3,500	No reasonable mixed alternative.			
NE-18	647,000 79,300	No reasonably feasible alternative.				Detailed nonstructural alternative being developed by Soil Conservation Service under PL-566.				No reasonable mixed alternative.			
NE-19	73,000 8,100	No reasonably feasible alternative.				19,000	2,100	2,500	300	No reasonable mixed alternative.			
NE-20	603,000 36,000	No reasonably feasible alternative.				20,400	1,200	21,900	1,800	No reasonable mixed alternative.			
NE-22	600,000 66,000	276,000	30,400	200,000	13,800	336,000	37,000	14,100	1,200	168,000	18,500	214,000	15,000
SS-23	4,385,000 482,500	Detailed Planning Investigations now being conducted in this watershed by U.S. Army Corps of Engineers.				98,200	5,900	47,100	3,900	15,500	27,000	310,000	22,900
SS-24	355,200 21,400	238,200	14,300	280,000	19,300	247,200	14,900	144,900	12,200	11,400	208,800	12,500	247,700
TA-48	437,400 26,300	377,400	22,700	110,000	7,600	96,000	5,800	8,700	800	5,100	No reasonable mixed alternative.		
TA-52	182,400 10,900	38,400	2,300	180,000	12,400	65,600	4,000	2,500	300	3,300	47,600	2,900	30,200
TA-54	122,600 7,300	104,600	6,200	28,500	1,900	697,800	41,900	13,400	1,200	8,300	103,800	6,200	284,200
TA-56	835,800 50,200	241,800	14,500	270,800	18,700	35,700				Conservation Service under PL-566.			
NB-60	2,049,600 367,900	Detailed Planning Investigations now being conducted in this watershed by Soil Conservation Service under PL-566.				No reasonably feasible non-structural alternative.				No reasonable mixed alternative.			
BB-42	488,700 88,000	--	3/	3,734,000	261,200	88,000							
BB-43	Crane Brook considered an integral part of BB-42 (Wewantic River)												
BB-45	211,300 38,200	--	3/	365,000	25,100	38,200	3/	500,000	31,900	38,200	No reasonable mixed alternative.		

1/ Price Base 1976.

2/ Amortized at 6-3/8 percent for 100 years.

3/ Less than \$5,000 in average annual damage remaining.

Another combination investigated was a floodproofing program to modify existing damageable property. A wide range of techniques was considered to reduce damage at individual locations. Permanent measures, such as the waterproofing of walls, were combined with contingency measures, such as removable flood barriers to safeguard interior areas from floodwaters. Emergency measures to be carried out during floods, such as pumping and removal of damageable material to flood-free areas, were also included in this alternative.

A third plan included the same structural measures, but combined with floodproofing. Land treatment, floodwater retarding structures, and dikes and floodwalls were used to reduce and control flood flows to manageable levels. Floodproofing measures were then utilized to reduce damage remaining from the reduced flows.

A large part of the damageable property in the region is not suited to economical floodproofing. Much of the road and bridge damage can only be reduced by reducing floodflows or enlarging the bridge. In other instances, floodproofing can create a potentially dangerous situation by giving residents a false sense of security. Residents may choose to remain in their floodproofed homes, when the more prudent action may be to evacuate to higher ground.

By utilizing floodproofing, in combination with structural measurements, it is often possible to reduce the cost and scope of a structural program while increasing the degree of protection afforded to the area.

Detailed investigations and analyses would be required to establish the most acceptable and effective combination of measures to reduce flood

damages in the region. The three combinations considered in this study illustrate a range of possibilities. Final selection of a plan would require significant local inputs, consideration of environmental impacts, and a cooperative effort by local, state, and federal agencies.

In order to limit flood damage to new development and to protect existing property owners from catastrophic loss, all communities in the region should participate in the National Flood Insurance Program. Under the Flood Insurance Program, communities are required to implement regulations and formulate effective flood plain restrictions, such as zoning and subdivision control.

8.4 SEDIMENT AND EROSION ALTERNATIVES

A. Construction Areas

Provisions should be made for the retention of optimum amounts of vegetative cover for watershed protection on all areas undergoing residential, highway, and industrial development and construction. Developers should prepare and follow plans designed to minimize the disruption of the hydrologic balance and the resulting erosion by maintenance of vegetative cover during construction. Contractors should utilize the natural landscape in their planning for environmental purposes. Where needed, developers and contractors should apply erosion control measures such as temporary debris basins or desilting basins, seeding and mulching of exposed areas, temporary diversions, and forest buffer zones.

Adequate planning prior to construction and close supervision of construction activities are needed to control erosion.

Naturally, developers will be reluctant to utilize erosion control measures, unless they can see some financial, aesthetic, or other tangible benefits. Consequently, sediment and erosion control ordinances and bylaws are needed to ensure compliance with good conservation practices during construction. These ordinances could be additions to present zoning, subdivision regulations, and/or building regulations.

B. Critical Erosion Areas

Isolated critical erosion areas in the region will continue to occur. In order to approach this problem on an orderly basis, we recommend the establishment of a measure in The Pilgrim Resource, Conservation and Development Area to inventory and map all critical erosion areas and problem streambanks. This inventory should be updated every 5 years. We also recommend that priorities be established within the RC&D Council to provide technical and financial assistance to stabilize critical areas.

C. Tilled Cropland

The Conservation Operations Program of the Soil Conservation Service can assist landowners in applying conservation measures to prevent erosion on

cropland. This technical assistance is coordinated through the conservation district and, in many instances, landowners can obtain cost sharing for installation of practices from the Agricultural Stabilization and Conservation Service.

Fiscal and personnel limitations make it necessary to establish priorities for technical and financial assistance. Priorities for technical assistance are provided by the conservation district board of supervisors in each county. Financial cost sharing program priorities are established by the Agricultural Stabilization and Conservation County Committee.

Since the installation of conservation practices is a purely voluntary effort on the part of landowners, priorities have tended to favor those farm operators who exhibit the most initiative and desire to install practices. The majority of technical assistance work is precipitated by landowner requests. This procedure has resulted in a good deal of assistance being provided to operators who are already highly motivated to install practices and who are aware of the benefits to be obtained from soil conservation efforts.

As a result of priority procedures and limitations on personnel and funding, many of the farms with severe erosion problems have not received much encouragement to install practices to alleviate the situation. However, these are the very operators who require the most encouragement, assistance, and continued follow-up, if they are to reduce erosion losses.

Cost sharing for conservation practices has favored production-oriented measures rather than erosion control practices. Naturally, the practices which are aimed toward increased production and increased farm income are popular with farmer-recipients. Erosion control practices which may result in a decrease in production tend to be less popular, though no less necessary.

If erosion losses on tilled cropland are to be reduced to acceptable levels, more emphasis will need to be placed on locating, contacting, encouraging, and assisting the farmers with the most severe problems. Since it appears unlikely that significant increases in funding or personnel levels will be forthcoming, other technical assistance and cost sharing measures will need to receive reduced emphasis.

A first step in reducing cropland erosion losses could involve a detailed cropland inventory to assess erosion losses and determine needed treatment for each farm in the conservation district. Priorities for assistance could then be established. SCS technicians should have definite annual goals to contact and assist high priority farm owners. Cost sharing assistance for erosion control practices on priority farms should be allocated the maximum possible funding, even if this acts to the detriment of some of the more popular production-oriented measures. Increased cost sharing for erosion measures with off-site sediment reduction benefits should receive high priority.

It is apparent that increased effort and financial assistance will be required to reduce erosion losses on cropland. The final decision concerning the emphasis to be placed on erosion control in relation to other conservation needs rests ultimately with the conservation districts and the ASCS county committees. A detailed cropland erosion inventory by each district is recommended as a logical starting point to promote discussion of the problems and to establish a coordinated program to meet needs.

8.5 WETLANDS ALTERNATIVES

In order to reduce projected wetland losses and to provide additional protection to inland wetland areas, this study has developed a hierarchy of protective measures to be pursued. The hierarchy is based on the degree of protection provided to the wetlands against unwise development. The basic preference list is, as follows:

1. Public and Quasi-public Ownership.
2. Restrictions under Massachusetts General Laws, Chapter 131, Section 40A, the Inland Wetlands Restriction Act.
3. Areas placed under special zoning regulations.
4. Protection under Massachusetts General Laws, Chapter 131, Section 40, the Inland Wetlands Protection Act.

This list of options was then employed to assist in the development of alternatives for additional wetlands protection.

A. Public Acquisition

Accelerated acquisition of inland wetlands by state, county, city, and town agencies could be implemented to add to the projected acquisition of 20,800 acres. State agency acquisition of wetlands will continue to utilize existing funds, such as the Inland Fish and Game Fund. In order to accelerate acquisition, particularly the Wetlands for Wildlife Program of the Massachusetts Division of Fisheries and Wildlife, additional funding from the Massachusetts legislature will be needed.

The Massachusetts Self-Help program should be funded on a regular basis. The U.S. Bureau of Outdoor Recreation's Land and Water Conservation Fund financing has been increased. A portion of the Self-Help funds and some of the Massachusetts share of the Land and Water Acquisition Fund should be earmarked for wetlands acquisition.

Projections indicate that about 20,800 acres of wetlands will be acquired by 1990 through existing programs. A reasonable goal for additional acquisition is 20,000 acres.

Priority for wetlands acquisition should go to the larger wetlands of the regions. These larger areas offer more potential for wildlife habitat than a like acreage of smaller units. Management of a large area is also likely to be easier than management of several smaller areas. In addition, the large areas offer the potential for lower per-

acre acquisition costs as the interior portions of the areas are likely to be without road access and be less valuable real estate.

The 85 wetlands evaluated by the Soil Conservation Service and further described in Chapter 5 are among the largest wetlands in the region.

Of this group, the wetlands with the highest ratings are:

Wetland No.	Name	Size (acre)	Approximate percent Publicly or Quasi- publicly Owned
3	Wenham Swamp	1,970	85
6	Ipswich River	660	5
22	Cedar Swamp	570	5
27	Hockomock Swamp	5,450	60
28	Beech Hill Swamp	580	15
30	Great Cedar Swamp	1,440	5
36	Chartley Brook	600	10
37	Titicut Swamp	430	5
40	Winnetuxet River	710	0
47	New Bedford Reservoir	310	0
48	Rocky Gutter Brook	1,000	85
49	Forbes Swamp	560	0
54	Acushnet Cedar Swamp	1,070	80

The Division of Fisheries and Wildlife is currently acquiring land in Wetland 27, Hockomock Swamp. This acquisition should be continued and early public acquisition should be considered for all of these highest rated wetlands.

B. Inland Wetlands Restriction Act

Progress in implementing the Restrictions Act has been agonizingly slow. Problems have resulted from the low staffing levels and the complexity of the project. Identification and location of wetland areas have been proceeding at an acceptable rate. The time-consuming procedures involve: transfer of wetlands data to assessor's maps, determination of wetland tract ownership, and preparation of legal descriptions of each piece of wetland slated for restriction. A significant increase in staff and funding for the Restriction Program is needed, if more rapid results are to be obtained.

C. Protective Zoning

Conservancy zones can be a useful tool for the protection of wetlands. Flood plain zones, wetland zones, and conservancy zones usually place significant restrictions against development. Nearly 46,000 acres of inland wetlands are now subject to some form of these special regulations. In some instances, only the major wetlands in a town have been included in these specially zoned areas.

Communities are encouraged to establish conservancy zones to protect their inland wetlands from unwise development. Such zoning should be comprehensive and include, as a minimum, all identified wetland areas above

5 acres in size. Communities with partial zoning of wetland areas are encouraged to expand coverage to include all wetland areas of significant size.

8.6 WATER QUALITY ALTERNATIVES

Nonpoint pollution sources need to be evaluated to determine their magnitude and effects on water quality. Results of the Section "208" water quality studies being conducted by regional planning agencies should be an indicator of the extent of nonpoint pollution problems in the region.

Local communities should place more emphasis on soils limitations when planning for growth. Detailed soil surveys made in region towns indicate severe limitations existing for septic tank systems. Communities adopting or updating local zoning ordinances need detailed soils information to intelligently guide growth to suitable areas. In some cases, the use of large residential lot size in certain soils can minimize septic tank-leach field problems, which might develop if smaller lot size and greater density of development were permitted. Conversely, smaller lot sizes may require sewage collection systems because of inadequate soils for onsite disposal.

On the basis of projected population increases and the lack of complete municipal sewerage, the following communities should obtain detailed soil surveys from the SCS to aid in guiding growth:

Eastham	Middleton	Saugus
Edgartown	Oak Bluffs	Tisbury
Gay Head	Peabody	Truro
Gloucester	Provincetown	Wellfleet
Lynnfield	Reading	

8.7 WATER SUPPLY ALTERNATIVES

Appendix A of this report identifies 33 locations which have potential as municipal water supply reservoirs. Topography of the potential storage basin, geology of the abutments and foundation, and land rights costs appear to be favorable.

Information in Appendix A was abstracted from the Inventories of Potential and Existing Upstream Reservoir Sites prepared by the Soil Conservation Service in cooperation with the Massachusetts Water Resources Commission. Data is based on reconnaissance level investigations, and much more detailed investigations are needed before any of the sites could be developed as a municipal water supply storage.

Communities in need of water supply are encouraged to study the possibilities offered by these potential reservoir sites and to take the necessary acquisition or zoning steps to protect suitable sites from development.

8.8 RECREATION ALTERNATIVES

The Pilgrim Resources Conservation and Development Area Plan of Action contains 26 "Public Water-Based Recreation and Fish and Wildlife Development" opportunities including 19 "Environmental Corridors" along rivers in the southern portion of the Coastal Region. Environmental Corridors have been proposed for the streams indicated in Table 8.3.

TABLE 8.3 - PROPOSED RC&D ENVIRONMENTAL CORRIDORS

Chartley Brook	Shingle Island and Copicut Rivers
Nemasket River	Forge and Taunton Rivers
Philips Brook	Town Brook
Schumatuscacant River	Lower Taunton River
Cole River	Threemile River
Lee River	North River
Runnins River	Parkers River
East Branch of Westport River	Lower Weweantic River
Paskamanset River	Mashpee River
Herring River	

The corridors have a variety of purposes including fish habitat improvement, improved water quality, nature study, proper land use, educational value, as well as passive and active recreation.

Planning and implementation of these environmental corridors is a suitable alternative to meet needs for canoeing, hiking, and picnicking.

The 1975 SCORP report identified 16 Coastal Region rivers which have potential for development as canoe trails. These rivers, identified in Table 5.26 of the report, are suitable alternatives to meet identified needs for canoeing in the region.

The North River, South River, Taunton River, and Ipswich River were also identified in SCORP as having potential under the Massachusetts Scenic and Recreational Rivers Act. Early implementation of the act is needed to protect the rivers and their banks from degradation. With protection, the rivers will be able to continue to provide passive recreational opportunities.

All three of these alternatives (environmental corridors, canoe trails, and scenic and recreational rivers) require a minimum of financial investment. The environmental corridors offer an opportunity for civic group and community involvement with cleanup along the shores. Canoe trails and the Recreational and Scenic Rivers Act will preserve existing conditions and maintain these important resources in the public view, while plans are made to develop passive recreation potential.

TABLE 8.4

COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Land Use Agricultural Land	1-1 Ignore situation and continue to let market forces operate to the demise of the agricultural sector.	1. Would not generate any positive solution to expressed needs.
NED	Land Use Agricultural Land	<p>1-2 Undertake a multi-faceted program whereby state and local officials, public and private institutions would actively press for public programs to preserve agricultural land by keeping land in agricultural production.</p> <p>a. Identify sources of comparative disadvantages and develop public policies and programs to minimize the disadvantages wherever possible.</p> <p>b. Complete soil surveys to determine most feasible locations of future developments while prohibiting their location on productive agricultural lands.</p> <p>c. Form task force to determine negative impacts of presently enacted and future legislation upon the agriculture sector and revise such legislation to minimize adverse impacts.</p> <p>d. Form task force to actively seek public programs to provide incentives for food and fiber processing and marketing firms to locate in the region.</p> <p>e. Form research task force to develop or locate new crops, crop and livestock products which could be produced in the region and thereby increase diversity of production.</p>	<p>1. Would have a positive impact in that 6,574 acres of agricultural land with production valued at \$1,181,216 (1967 constant dollars) would be preserved and would meet the expressed need of maintaining the agricultural lease.</p> <p>a. Would increase economic viability and thereby contribute to reversing trend of agricultural land loss.</p> <p>b. Would minimize adverse impacts of development upon agriculture and would contribute to EQ needs as well.</p> <p>c. Would potentially help to minimize the impact of some ordinances (e.g., zoning ordinances) that promulgate specific goals but create incentives which are in opposition to those goals.</p> <p>d. Same as a. above.</p> <p>e. Same as a. above.</p>
NED & EQ	Land Use Forestland	1-3 Increase management of public and private land by increasing personnel working on state land and personnel providing technical assistance to private landowners.	<p>1. Will meet about 14 percent of the 1990 needs for wood products.</p> <p>2. Increase the acres managed by about 36 percent.</p> <p>3. Adequately meets the need for technical assistance on urban forest management.</p>

TABLE 8.4 COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Land Use Forestland	1-4 Increase incentives to landowners to encourage them to manage their forestland for timber.	1. Will meet about 36 percent of the 1990 needs for wood products. 2. Increase the acres presently managed by about 89 percent. 3. Will meet the need for increased incentives in the area.
		1-5 Establish a program to develop diversified markets for low quality products.	1. Will meet about 16 percent of the 1990 needs for wood products. 2. Increase the acres presently managed by about 40 percent. 3. Over a period of time this program will meet nearly all the needs for diversified markets.
		1-6 Establish an information and education program to inform private landowners about the benefits of forestland management.	1. Will meet about 3 percent of the 1990 needs for wood products. 2. Increase the acres presently managed by about 19 percent. 3. Adequately meet the needs for knowledge on forestland management. 4. Adequately meets the need for knowledge on urban forestland management.
NED	Flooding	2-1 Nonparticipating cities and towns participate in the HUD Flood Insurance Program.	1. Limits future development of flood-prone areas and encourages communities to consider flood hazards when planning growth.
NED	Flooding	2-2 Implement structural measures to reduce flood damage in the following subwatersheds: IP-4, NS-5, NS-6, NE-22, and TA-56.	1. Reduces average annual flood damage from \$351,000 to \$152,000.
NED	Flooding	2-3 Implement floodproofing measures to reduce flood damage in the following subwatersheds: IP-4, NS-5, NS-6, NS-8, NE-19, NE-20, NE-22, SS-24, TA-52, TA-54, TA-56, and BB-45.	1. Reduces average annual flood damage from \$493,000 to \$205,000.

TABLE 8.4

COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Flooding	2-4 Implement a combination of structural and flood-proofing measures to reduce flood damage in the following subwatersheds: NS-5, NS-6, NE-22, TA-54, and TA-56.	1. Reduces average annual flood damage from \$238,000 to \$83,000.
EQ	Erosion and Sediment	3-1 Establish erosion and sediment control ordinances in municipalities with the most potential for urban development.	1. Reduces erosion on the 9,500-acres per year undergoing urbanizing development.
EQ	Erosion and Sediment	3-2 Establish a project measure in The Pilgrim RC&D Area to inventory all critical areas. Stabilize problem areas, using technical and financial assistance through the RC&D project.	1. Reduces erosion from the critical erosion areas of nearly two-thirds of the region.
NED	Erosion and Sediment	3-3 Inventory farmland erosion. Establish priority areas for installation of erosion control measures. Encourage and assist high priority landowners to solve cropland erosion problems. Increase cost-sharing for erosion measures.	1. Places increased SCS Conservation Operations Program and ASCS cost-sharing emphasis on cropland erosion practices.
EQ & NED	Wetlands	4-1 Accelerate wetlands acquisition programs to acquire an additional 20,000 acres of regionally important wetlands.	1. Reduces projected wetland loss. 2. Provides public access to inland wetlands for passive recreation.
EQ	Wetlands	4-2 Accelerate the Inland Wetlands Restriction Program.	1. Reduces projected wetland losses.
EQ & NED	Wetlands	4-3 Expand conservancy zoning for wetland areas.	1. Reduces projected wetland losses. 2. Provides additional protection to the 80,950-acres of inland wetlands which are not protected by public ownership, or the Inland Wetland Restriction Act.
EQ	Water Quality	5-1 Obtain detailed soil surveys and use them to guide growth in the following communities: <div> <div>Eastham</div> <div>Edgartown</div> <div>Gay Head</div> <div>Lynnfield</div> </div> <div> <div>Middleton</div> <div>Oak Bluffs</div> <div>Gloucester</div> <div>Provincetown</div> </div> <div> <div>Reading</div> <div>Saugus</div> <div>Tisbury</div> <div>Wellfleet</div> </div>	1. Reduces the potential harmful effects on water quality caused by malfunctioning septic tank systems located in unsuitable soils. 2. Has benefits in the area of land use by directing development away from "sensitive areas." 3. Has benefits in land use (agricultural land) by identifying prime agricultural land and land of state and local importance for farming.

TABLE 8.4

COMPARISON OF ALTERNATIVES AND NEEDS

National Objective	Study Concern	Alternatives	Comparison with Needs
NED	Water Supply	6-1 Communities investigate water supply opportunities offered by the 33 reservoir sites identified in Appendix A.	1. Identified reservoir sites have potential to supply nearly 48 million gallons per day of safe yield.
NED	Water Supply	6-2 Potential reservoir sites which can meet community water supply needs are acquired or otherwise protected from development which would make them unavailable or prohibitively expensive when needed as water supplies.	1. Reservoirs which have potential to meet a specific community need for water supply will be available when needed.
NED & EQ	Recreation	7-1 Establish environmental corridors along 19 selected streams in the region.	1. Provides passive recreation opportunities. 2. Increases public awareness of environmental resources.
NED	Recreation	7-2 Establish canoe trails on 16 rivers in the region.	1. Provides opportunities for canoeing to meet identified needs.
NED & EQ	Recreation	7-3 Implement the Massachusetts Scenic and Recreational Rivers Act for four of the region's rivers.	1. Protects a potential recreation resource from degradation or loss. 2. Increases public awareness of environmental resources. 3. Provides potential passive recreation opportunities.
NED & EQ	Recreation	7-4 Establish regional programs for protection of unique natural areas.	1. Increase public awareness of environmental resources. 2. Protects passive recreation resources.

8.9 ALTERNATIVE ACCOUNTS DISPLAY

The Water Resources Council's Principles and Standards for Planning of Water and Related Land Resources require that a system of information accounts be established to display beneficial and adverse effects of each alternative proposed to meet an objective. The effects of each alternative on national economic development environmental quality, regional development and social well-being are indicated to provide a basis for comparing alternatives. The purpose is to display beneficial and adverse effects so that different levels of achievement of each objective and trade offs between alternatives can be discerned and compared. Table 8.5 presents the Alternative Accounts Display.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
1-Land Use	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Adverse Effects</u>	<u>Adverse Effects</u>
1-1 Agricultural Land - continue present land policies.	<p>Minimizes public costs relative to preservation programs.</p> <p><u>Adverse Effects</u></p> <p>Projected loss of 6,574 acres resulting in a decrease of \$1,181,000 in agricultural production.^{1/}</p> <p>Pro-rated cost of administering zoning ordinances.</p> <p>Loss of tax revenue from agricultural-horticultural assessments.</p>	<p>Continuing loss of agricultural land will decrease amounts of herbicides, pesticides and fertilizer nutrient entering water resources through runoff.</p> <p>Less erosion and sedimentation resulting from less land being cultivated.</p> <p><u>Adverse Effects</u></p> <p>Less diversified land use mix, thus lowering the aesthetic quality of the region.</p> <p>Adverse impact upon wildlife feeding habitat through a decrease in boundary areas of open and forestland.</p>	<p>Adverse to the extent that loss of agricultural production (amounting to \$1,181,000 from 6,574 acres) results in loss of input and output agricultural service and marketing facilities.^{2/}</p>	<p>Decrease in agricultural land decreases the aesthetic qualities of the area.</p> <p>Increase in food costs to extent of increased transportation charges for increased food imports.</p>

1/ Approximate agricultural valuations (state averages) were computed by Dr. E. Engle, Department of Food and Resource Economics; University of Massachusetts (1974) for eight categories of agricultural land. Shade tobacco and nurseries: \$480-720/acre; binder tobacco, vegetables, potatoes: \$150-230/acre; cropland, pasture (tillable): \$110-170/acre; orchards: \$160-240/acre; cranberry bogs: \$560-840/acre; untillable permanent pasture: \$40-60/acre; farm woodland: \$20-30/acre; nonproductive farm woodland: \$5-7/acre.

2/ Loss of acreage was multiplied times average value of production per acre and expressed in 1967 dollars.

TABLE 3.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>1-Land Use</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>
1-2 Agricultural land - preserve or increase existing quantities of agricultural land.	Net earning and subsequent tax revenues that would be lost without preservation - \$1,181,000. Food cost savings to extent that decrease in food products would be imported from other areas, thus increasing food prices.	Benefit would be derived to the extent that preservation of agricultural land would enhance the aesthetic qualities of diversified land use mix. Maintaining agricultural land would preserve boundary areas which would enhance wildlife habitat.	Benefits accrue to the extent that rates of unemployment and underemployment fall relative to such rates if land were not preserved. Much tourism due to aesthetic qualities which are enhanced through the maintenance of a diversified land use mix. Benefits accrue to the extent that agricultural land enhances the tourist industry.	Social well-being is enhanced to the extent that preservation measures enhance the aesthetic qualities of the region. To the extent that preservation measures result in lower food prices than would exist without a Preservation Program, SW-B is increased.
	<u>Adverse Effects</u> Costs of preservation measures more expensive than present policies. ^{1/}	<u>Adverse Effects</u> Increases pesticide, herbicide and other residues entering water areas through runoff has a detrimental impact on environmental quality. Increased erosion and sedimentation resulting from cultivating preserved acreage.	<u>Adverse Effects</u> One potential adverse impact stems from the development that would occur on the preserved acreage without a preservation program and that which would not occur with a preservation program. Although there is enough developable land in the region, even with a Preservation Program, added costs of developing nonpreserved land may result in some firms locating elsewhere.	<u>Adverse Effects</u> To extent society is adversely effected by noise and smells of agricultural production.
	A. Purchase lease-back program: Initial cost of purchase (\$600-\$3,000 per acre) minus revenues derived from renting to agricultural entrepreneurs.			
	B. Development Rights Program: Cost of Purchasing Development Rights.			

^{1/} Values of agricultural land in the region are dependent upon provision of roads, water, sewer, electricity and physical characteristics. A purchase lease-back program would involve a \$600-\$3,000 range. Prices that would be relevant for a Development Rights Program would be to determine an acceptable rate of return per acre and from that determining the capital cost of purchasing that land based on an acceptable return and subtracting the capital cost/acre from the market value of the land. This program is further complicated by the fact that, although almost all agricultural land is zoned residential, much land would not be developed due to location of flood plains, wetlands, and/or the physical characteristics of the land itself. Thus, under these circumstances, prices of development rights would be negligible.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>1-Land Use</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>
1-3 Increase management of public and private land by increasing personnel working on state land and personnel providing technical assistance to private landowners.	<p>Sawtimber-900,000 c.f./yr. valued at \$466,000</p> <p>Pulpwood-430,000 c.f./yr. valued at \$95,460</p> <p>Recreation General-1,000,000 V.D./yr.1/ valued at \$2,000,000</p> <p>Recreation Special-1,600,000 V.D./yr. valued at \$7,950,000</p> <p>Water-6700 A.F. valued at \$17,000.</p> <p><u>Adverse Effects</u></p> <p>Variable costs-\$357,000/yr.</p> <p>Implementation costs-\$39,000.</p>	<p>Increase in technical services for urban forest management.</p> <p>Improvement in wildlife habitat by creating a more diverse forest cover.</p> <p>Increased management and protection enhances the benefits provided by forestland.</p> <p>Increase in technical assistance insures the protection of the quality of soil, water and aesthetics.</p> <p><u>Adverse Effects</u></p> <p>Increase sediment yield by 18.5 tons/yr.</p>	<p>Increase employment by hiring 8 professionals, 8 technicians and 17 woods workers.</p> <p>Increase in cut provides additional wood for presently underutilized mill capacity; provides increase in income to loggers and mills from additional wood; provides increase in revenues from tourism.</p> <p>Increase in industry employment because of increase harvest.</p> <p>Increase in recreational employment because of increase in visitor days.</p>	<p>Increased employment from more state, industry and recreational employment.</p>
<u>1-4 Increase incentives to landowners to encourage them to manage their forestland for timber.</u>	<p><u>Beneficial Effects</u></p> <p>Sawtimber-1,100,000 c.f./yr. valued at \$570,000</p> <p>Pulpwood-2,000,000 c.f./yr. valued at \$440,000</p> <p>Recreational General-46,500 V.D./yr. valued at \$93,000</p> <p>Recreation Special-1,200,000 V.D./yr. valued at \$5,900,000.</p> <p><u>Adverse Effects</u></p> <p>Variable Costs-\$115,000/yr. Implementation costs-\$10,000.</p>	<p><u>Beneficial Effects</u></p> <p>Increase in forest management promotes and enhances benefits derived from forestland for now and in the future.</p> <p>More forestland managed decreases loss to urban development.</p> <p>Decreases sediment yield by 70 tons/yr.</p>	<p><u>Beneficial Effects</u></p> <p>Increases in regional income due to increase timber harvesting and recreation V.D.</p> <p>Enhances future employment because of increased forest productivity.</p>	<p><u>Beneficial Effects</u></p> <p>Increases the present and future employment.</p>

1/ V.D. = Visitor Days.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>1-Land Use</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial Effects</u>
1-5 Establish a program to develop diversified market for low quality products.	Sawtimber-500,000 c.f./yr. valued at \$265,000 Pulpwood-1,000,000 c.f./yr valued at \$220,000 Recreation Special-1,200,000 V.D./yr valued at \$2,400,000 Water-34,000 A.F. valued at \$85,000 <u>Adverse Effects</u> Variable Costs-\$204,000/yr. Implementation Costs-\$1,500,000.	Increase in utilization promotes increase in wildlife habitat and provides better forest management practices. Provide market for forest products from land clearing, decreases burning and land fills. <u>Adverse Effects</u> Increases sediment yield by 21 tons/yr.	Increase in employment dependent upon plant size. Addition of two professionals to state employment. <u>Adverse Effects</u> Implementation cost of \$1,500,000 by private industry. Annual operating cost of \$150,000.	Increased employment from industry and state. Increased recreation close to urban centers.
1-6 Establish an information and education program to inform private landowners about the benefits of forestland management.	<u>Beneficial Effects</u> Sawtimber-460,000 c.f./yr. valued at \$240,000 Pulpwood-230,000 c.f./yr. valued at \$51,000 Recreation General-735,000 V.D./yr. valued at \$1,470,000 Recreation Special-1,018,000 V.D./yr valued at \$5,000,000 Water-36,000 A.F./yr valued at \$90,000 <u>Adverse Effects</u> Variable Cost-\$72,000/yr.	<u>Beneficial Effects</u> Provide information to urban forest landowners on management opportunities. Urban forestry technical assistance will help make development of forestland more environmental and aesthetically sound.	<u>Beneficial Effects</u> Increase income to area by increasing visitor days, valued at \$9,000,000. Increased income from an increase in employment from more recreation and timber harvesting.	<u>Beneficial Effects</u> More aesthetic urban environment Increased employment. Increase in recreational opportunities close to urban centers.

ALTERNATIVE ACCOUNTS DISPLAY

TABLE 8.5

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>2-Flooding</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
2-1 Nonparticipating cities and towns participate in the HUD Flood Insurance Program.	Prevents increases in damageable properties. <u>Adverse Effects</u> \$125,000 initial cost of program. \$4,000 per year for operation and management of program.	Renewable resource lands (flood plains) protected as a result of required land use regulations. Tends to maintain existing water quality by preventing building development close to streams. Maintenance of streamside habitats minimizes hazards to endangered species of animals, fish and plants.	Prevents increases in damageable properties. Prices of buildable land may go up, thus increasing property values. <u>Adverse Effects</u> Flood plain land no longer available for residential, commercial or industrial use. Prices of buildable land may go up which may adversely effect industrial and commercial activity. \$2,500 per year for regional operation and management costs of program.	Psychological satisfaction from the action. Program will help maintain present neighborhood character in vicinity of flood hazard areas. Remaining uplands will be subject to accelerated neighborhood change. Present landowners may face loss of property value due to program. Provides an equitable distribution of flood hazard risks.
Joining the program entails establishing effective flood plain restrictions; such as, zoning, subdivision controls and building regulations for development within the flood plains.				
<u>2-2 Implement structural measures. A program of structural measures is economically feasible in the following subwatersheds:</u>	<u>Beneficial Effects</u> Average annual flood damage will be reduced by \$199,000. <u>Adverse Effects</u> Average annual cost is estimated to be \$44,000.1/	<u>Beneficial or Adverse Effects</u> Irreversible commitment of land for program measures. Streams altered for project measures.	<u>Beneficial Effects</u> Developed land no longer subject to flooding from 100-year storm. Average annual damage will be reduced by \$199,000. Creates 20 man years semi-skilled employment. <u>Adverse Effects</u> Local average annual cost is estimated to be \$5,000.	<u>Beneficial or Adverse Effects</u> Reduce health and safety hazards associated with flooding. Psychological satisfaction from the action. Some landowners may be adverse to the action. Creates 20 man years semi-skilled employment.

1/ Discount estimated evaluation period.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>2-Flooding</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
2-3 Implement floodproofing measures.	Average annual flood damage will be reduced by \$288,000.	May adversely effect appearance of some existing structures.	Average annual damage will be reduced by \$288,000.	Reduces health and safety hazards associated with flooding.
A program of floodproofing existing structures is economically feasible in the following sub-watersheds: IP-4, NS-5, NS-6, NS-8, NE-19, NE-20, NE-22, SS-24, TA-52, TA-54, TA-56, BB-45.	<u>Adverse Effects</u> Average annual cost is estimated to be \$60,000.		Will create 25 man years semi-skilled employment.	Psychological satisfaction from the action.
			<u>Adverse Effects</u> Local average annual cost is estimated to be \$55,000.	Some landowners may be adverse to the action. Will create 25 man years semi-skilled employment.
<u>2-4 Implement both structural measures and flood proofing.</u>	<u>Beneficial Effects</u> Average annual damage will be reduced by \$155,000.	<u>Beneficial or Adverse Effects</u> Irreversible or irretrievable commitment of land for program measures.	<u>Beneficial Effects</u> Average annual damage will be reduced by \$155,000.	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action.
A program combining structural measures with floodproofing is economically feasible in the following subwatersheds: NS-5, NS-6, NE-22, TA-54, and TA-56.	<u>Adverse Effects</u> Average annual cost is estimated to be \$49,000.	Stream channel altered for project measures. May adversely effect the appearance of some existing structures.	Developed land no longer subject to flooding from 100-year storm. Will create 20 man year semi-skilled labor.	Some landowners may be adverse to the action. Will create 20 man years semi-skilled labor. Reduces health and safety hazards associated with flooding.
			<u>Adverse Effects</u> Local average annual cost is estimated to be \$7,500.	
<u>3-Erosion & Sediment</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
3-1 Establish erosion and sediment control ordinances in municipalities with the most potential for urban development.	25,000 tons/yr. sediment damage reduction.	Reduce erosion on 9,400 acres/year of construction sites.		Will increase cost of developing land for urban purposes.
	<u>Adverse Effects</u> \$75,000 initial capital cost to initiate program. Two man years to manage program.	Eliminate 25,000 tons/yr. of construction site produced sediment. Improvement of water quality downstream.	<u>Adverse Effects</u>	

TABLE 8.5
ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>3-Erosion & Sediment</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
3-2 Establish a project measure in The Pilgrim Area RC&D project to:	\$200,000 per year sediment damage reduction.	Reduce erosion on critical erosion problem areas and problem streambanks.	Will create 40 semi-skilled jobs for 1 year.	Will create 40 semi-skilled jobs for 1 year.
- Inventory and map all critical areas and problem streambanks. This inventory to be repeated at 5 year intervals.	<u>Adverse Effects</u> \$175,000/year cost of program.	Eliminate sediment from these sources. Improve stream water quality.	<u>Adverse Effects</u>	Psychological satisfaction from the action.
- Stabilize these problem areas with technical and financial assistance provided through the RC&D project.				
<u>3-3 Inventory cropland erosion problems. Establish priorities for assistance in the planning and installation of erosion control practices.</u>	<u>Beneficial Effects</u> Productivity of farmland is maintained.	<u>Beneficial or Adverse Effects</u> Reduces potential sediment reaching watercourses.	<u>Beneficial Effects</u> Productivity of farmland is maintained.	<u>Beneficial or Adverse Effects</u>
<u>4-Wetlands</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
4-1 An accelerated acquisition program to acquire an additional 20,000 acres (20,800 acres are expected to be acquired under ongoing programs) of regionally important wetlands.	Will contribute to meeting recreational and educational needs. Tends to maintain recreational quality of 20,000 acres. <u>Adverse Effects</u> Average annual cost is estimated to be \$900,000.	Will tend to preserve existing wildlife habitat. May preserve environmentally unique and valuable areas. Irreversible commitment of 20,000 acres prevented. Tends to maintain existing water quality. Tends to maintain low flow regime.	Will contribute to meeting recreational and educational needs of region. <u>Adverse Effects</u> Average annual cost is estimated to be \$900,000. Prices of buildable land may increase and adversely effect economic activity. Decrease property tax base. Initial capital cost is estimated to be \$15,000,000.	Psychological satisfaction from the action. Some resource owners may be adverse to the action.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>4-Wetlands</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
4-2 Accelerate Inland Wetland Restriction Program.	Will contribute to meeting recreational needs. <u>Adverse Effects</u> Annual cost is estimated to be \$250,000.	May lead to preservation of environmentally unique and valuable areas. Will tend to preserve existing wildlife habitat. Tends to maintain existing water quality.	<u>Adverse Effects</u> Annual cost is estimated to be \$250,000.	Psychological satisfaction from the action. Some resource owners may be adverse to the action.
4-3 Expand Conservancy Zoning for wetland areas.	<u>Beneficial Effects</u> Discourages improper land use of wetlands.	<u>Beneficial or Adverse Effects</u> Will tend to preserve existing wildlife habitat. May preserve environmentally unique and valuable areas. Irreversible commitment of 35,000 acres prevented. Tends to maintain existing water quality Tends to maintain low flow regime.	<u>Beneficial Effects</u> <u>Adverse Effects</u> Initial capital cost is estimated to be \$50,000. Prices of buildable land may increase and adversely effect economic activity. Decrease property tax base.	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action. Some resource owners may be adverse to the action.
<u>5-Water Quality</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
5-1 Obtain detailed soil surveys and use them to aid in guiding growth in the following communities: Eastham Peabody Edgartown Plainville Gay Head Provincetown Gloucester Reading Lynnfield Saugus Middleton Tisbury Oak Bluffs Wellfleet	Assists in determining least cost alternatives to solving water quality problems. <u>Adverse Effects</u> Initial cost is estimated to be \$180,000.	Provides tool for maintaining present quality of all water and related land resources.	Will create 6 man years employment for a professional soil scientist. <u>Adverse Effects</u> Initial cost to towns within the region is estimated to be \$90,000.	Psychological satisfaction from the action. Provides basis for determining public health problems associated with water quality.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>6-Water Supply</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
6-1 Investigate potential surface water reservoir sites for use as municipal water supplies.	<u>Adverse Effects</u> Cost of investigations.		More fully evaluates the potential of these reservoir sites.	Provides community with sound data upon which to base future planning.
<u>6-2 Acquire or otherwise protect suitable potential surface water reservoir sites.</u>	<u>Beneficial Effects</u> Potential reservoir site is available when needed to provide water for economic growth. <u>Adverse Effects</u> Cost of land purchase or easements.	<u>Beneficial or Adverse Effects</u> Present land use is maintained. Future land use may change to open water.	<u>Beneficial Effects</u> Potential reservoir site is available when needed to provide for regional economic growth.	<u>Beneficial or Adverse Effects</u> Assures water supply for future needs.
<u>7-Recreation</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
7-1 Establish environmental corridors.	Provides passive recreation opportunities. <u>Adverse Effects</u> Cost involved in implementing program.	Increases public awareness of the resource.		Psychological satisfaction from the action. Some landowners may be adverse to the action.
<u>7-2 Establish canoe trails.</u>	<u>Beneficial Effects</u> Provides passive recreation opportunities. <u>Adverse Effects</u> Cost involved in implementing program.	<u>Beneficial or Adverse Effects</u> Increases public awareness of the resource.	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u> Psychological satisfaction from the action. Some landowners may be adverse to the action.

TABLE 8.5

ALTERNATIVE ACCOUNTS DISPLAY

Alternative	National Economic Development (NED)	Environmental Quality (EQ)	Regional Development (RD)	Social Well-Being (SW-B)
<u>7-Recreation</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>	<u>Beneficial Effects</u>	<u>Beneficial or Adverse Effects</u>
7-3 Designation of the following rivers as components of the Massachusetts Scenic and Recreational Rivers System (Mass. General Laws, Chapter 21, Section 17B).	Positive step in initiating future alternatives of economic significance.	Maintains present water quality. Insures preservation of stream character.	Provides 1 skilled temporary part-time job.	Psychological satisfaction from the action.
a. North River	<u>Adverse Effects</u>	Positive step in initiating future environmental alternatives.	<u>Adverse Effects</u>	Some landowners may be adverse to the action.
b. South River	Average annual cost of administering and enforcing the program is estimated to be \$3,000.		Prices of buildable land may go up which may adversely effect industrial and commercial activity.	Provides 1 skilled temporary part-time job.
c. Ipswich River				
d. Taunton River				

8.10 ENVIRONMENTAL IMPACTS

Table 8.6, Potential Environmental Impacts of Alternatives, summarizes the potential impacts that suggested alternatives may have upon fifteen key environmental factors. It also includes an assessment of the irreversible or irretrievable commitment of resources resulting from each alternative. Effects on air quality, migration routes, and archeological and historic resources were also considered. The alternatives are not expected to have a significant impact on air quality or migration routes. Archeological and historic resources cannot be assessed at this level of investigation. Structural alternatives, such as Alternative 6-2, surface water reservoirs for water supply, could result in an adverse impact upon archeological and historic resources. Such impacts would have to be evaluated during final planning stages.

Expected impact on each environmental factor is indicated by (x) when the alternative maintains or improves the situation; (-) when the alternative has a negative impact; and (0) when an alternative has both favorable and adverse impacts and/or has significant impacts, for which an adequate determination cannot be made at this time. No entry indicates that no significant impact is expected.

This table represents best judgement on possible effects based on all available information. It is expected that detailed planning of any alternative will investigate the significant environmental impacts indicated in this table.

TABLE 8.6

POTENTIAL ENVIRONMENTAL IMPACTS OF ALTERNATIVES

SIGNIFICANT ENVIRONMENTAL IMPACTS ON: 1/																	
	Erosion & Sedimentation	Water Table	Changes Flow	Regime	Changes Land Use	Upland Wild- life Habitat	Bottomland Wetland Habitat	Bottomland Wetlands	Stream Fisheries	Wetlands	Rare or Endangered Animals, Plants	Intermittent Streams	Perennial Streams	Water Quality	Water Quality Incl. Receiving Water	Appearance of the Landscape	Irreversible & Irretrievable Commitment of Resources 2/
1-1 Continue Present Agricultural Land Policies					0	-	-		0					0		-	+
1-2 Preserve Agricultural Land	0				+	+	+							0		+	+
1-3 Increase Forest Management	0						+							0	0	0	+
1-4 Increase Forest Management Incentives							+										+
1-5 Develop Diversified Timber Markets	0															0	+
1-6 Establish Information & Education Program							+										+
2-1 Flood Insurance	+		+		+		+	+	+	+			+	+	+	0	+
2-2 Structural Flood Protection Program	0	0	0	0	0	0	0	0	-	0			-	0	0	0	-
2-3 Floodproofing										0				+	0	0	-
2-4 Structural & Floodproofing	0	0	0	0	0	0	0	0	-	0				0	0	0	-
3-1 Erosion and Sediment Control Ordinance	+	+				+	+	+	+	+		+	+		+	+	+
3-2 RC&D Critical Area Restoration	+					+	+	+	+	+		+	+		+	+	+
3-3 Cropland Erosion Program	+													+	+		+
4-1 Wetlands Acquisition		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4-2 Accelerate Inland Wetlands Restrictions		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4-3 Expand Conservancy Zoning		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5-1 Soil Survey - 14 Towns	+	+			+	+	+	+	+	+		+	+	+	+	+	+
6-1 Investigate Potential Water Supplies																	+
6-2 Acquire or Protect Water Supply Sites					+						+					+	+
7-1 Environmental Corridors	+				+		+			+	+	+	+	+	+	+	+
7-2 Canoe Trails													+	+			+
7-3 Massachusetts Scenic Recreation Rivers	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+
7-4 Regional Protection of Unique Areas																+	+

1/ + Maintains or improves present situation. - Adverse impact expected. 0 Could have adverse and/or favorable impact. Blank no significant impact is expected.

2/ + No irreversible or irretrievable commitment of resources. - Involves an irreversible and irretrievable commitment of resources.

CHAPTER 9 - PROGRAM IMPLEMENTATION OF ALTERNATIVES

9.1 INTRODUCTION

This chapter identifies program opportunities available for implementing the Alternatives identified in Chapter 8. Existing federal, state, and local programs are outlined, which will enable the Alternatives to be turned into action. The ultimate result of the Massachusetts Water Resources Study is hopefully not a mere list of alternatives to meet needs but, rather, a catalyst for action designed to meet those needs.

9.2 OPPORTUNITIES FOR USDA PROGRAMS

A. Soil Conservation Service Programs

Resource Conservation and Development Program

The Soil Conservation Service is the lead USDA agency for The Pilgrim RC&D Area which has been established to "improve the quality of life in the area (Bristol, Plymouth, Dukes, Barnstable, and Nantucket Counties) through a coordinated effort to provide local decision-makers with technical information and financial aid for action-oriented measures, which seek to better utilize, manage, and protect the area's unique natural resources." The RC&D Area can provide financial and technical assistance measures for Critical Area Treatment for erosion

and sediment control, Flood Prevention, Farm Irrigation, Land Drainage, Public Water-Based Recreation, and Fish and Wildlife Development, Soil and Water Conservation Management for Agriculture-Related Pollution Control, and Water Quality Management.

The RC&D Area could serve as a vehicle for implementing Alternative 2-2, Structural Flood Protection Program, for measures where social or economic benefits to the area will result. Up to one hundred percent federal cost sharing for technical assistance and structural measures for flood control is available. Local sponsors must provide all necessary land rights.

The RC&D Area could also assist in implementing Alternative 1-5, Establish a Program to Develop Diversified Markets for Low Quality Products.

The Critical Area Inventory, Alternative 3-2, could also be implemented under the auspices of the RC&D Program. Technical assistance to assess the extent of the problem and financial assistance to correct critical erosion areas is available. Up to 75 percent federal cost sharing is available to install corrective measures. Local sponsors must provide needed land rights and 25 percent of the project installation costs.

Establishment of Environmental Corridors, Alternative 7-1, along the streams of The Pilgrim Area are listed as RC&D Area measures. Technical assistance to plan and implement the corridors is available.

Conservation Operations Program

This is the ongoing program of the Soil Conservation Service. Technical assistance is available through the county conservation districts for the planning and installation of measures to develop and conserve natural resources. Field offices located in Acton and Raynham provide this technical assistance in the Coastal Region.

Assistance is available to local communities in the establishment of Erosion and Sediment Control Ordinances (Alternative 3-1). Sample by-laws have been developed by the National Association of Conservation Districts and governmental research agencies. Communities can also utilize the ordinances of nearby communities for guidance. Personnel from the Soil Conservation Service can assist towns in recognizing the special erosion needs of their particular community.

Technical assistance is available to the conservation districts to prepare the Inventory of Cropland with Serious Erosion Problems (Alternative 3-3). Technical assistance is also available to landowners desiring to reduce erosion losses through the utilization of conservation practices.

Soil Survey Program

Soil Surveys conducted by the Soil Conservation Service include the mapping, classification, correlation, and interpretation of soils

according to national standards. Soil mapping has been completed for much of the Coastal Region (See Figure 5-17). Communities may accelerate the completion of mapping by sharing the cost of soil surveys within the town boundaries. The soil survey program of the Soil Conservation Service can be used to implement Alternative 5-1.

Soil surveys are an essential element of basic data in the identification of prime agricultural land and are a first step in any program to protect prime agricultural land from urban development. Alternative 1-2, Preserve Agricultural Land, will rely on accurate soil survey data being available.

Public Law 83-566

The Small Watershed Protection and Flood Prevention Act provides technical and financial assistance to solve land and water problems. Flood prevention must be a major concern in each watershed.

Federal cost sharing is available to provide 100 percent of the cost of structural measures to provide flood protection, and 50 percent of the cost of multipurpose reservoir storage allocated to recreation or fish and wildlife developments. Non PL-566 cost sharing must be provided by local sponsors who must also provide all necessary land rights needed for project installation.

At the present time, federal cost sharing for nonstructural or flood-proofing methods of reducing flood damage is not available under PL-566 or other federal flood protection programs. PL-566 can, however, assist local communities to develop plans for nonstructural flood protection, if this is the most feasible and acceptable alternative. All installation costs must be borne by non PL-566 funds.

The structural measures studied for each watershed with significant damage predominantly include the use of floodwalls or earthen dikes to provide flood protection to an industry or business that sustains major damage. In many cases, residential damage remains, since there is no feasible system of protecting this property in most of the watersheds. Reservoir sites have been encroached upon or have been completely developed with buildings. In other cases, the flat topography limits the number of potential flood prevention sites. In the areas with a large percentage of upstream wetlands, peak flood flows are often below the minimum release rates required for design of a floodwater retarding structure.

Public Law 83-566 requires that needed structural works of improvement not be single purpose local flood control measures or water development projects which could be more appropriately carried out with federal assistance provided under other authorities. This is the case for many of the strictly structural alternatives which protect the major damage area, usually an industry located along the banks of the river.

PL-566 can, however, be utilized to plan and implement multiple-purpose projects and local protection measures combined with other water resource development.

Massachusetts Natural Resources Planning Program (MNRPP)

This local initiative program enables communities to inventory their natural resources, to rate those resources against standards, and to determine the consequences of proposed actions on the natural resource base. A Regional Technical Team is available to assist the townspeople to assess their resources and problems. Graduate student interns work with local residents to collect and analyze data.

The Massachusetts Natural Resources Planning Program is a useful tool in assessing the magnitude of resource problems and in developing courses of action to solve the problems. Preservation of Agricultural Land (Alternative 1-2), Critical Area Inventories (Alternative 3-2), Wetlands Acquisition (Alternative 4-1), Conservancy Zoning (Alternative 4-3) and Environmental Corridors (Alternative 7-1) should all be more easily implementable in a town participating in the Massachusetts Natural Resources Planning Program. Basic inventories needed for the program and the increased public awareness of the natural resource base will be useful in laying the foundations for implementation of alternatives.

B. Forest Service Programs

Renewable Resources Program

This is an "umbrella" program which combines many of the Forest Service authorities into a unified group of systems for recreation, wildlife, timber, land and water conservation, and human and community development. The Forest Service cooperates with the Massachusetts Department of Environmental Management, Division of Forests and Parks, to conduct forestry programs on state and privately owned forestland.

The Renewable Resources Program can provide assistance to forest landowners to Increase Management of Public and Private Forest Land (Alternative 1-3), assist in establishing a Program to Develop Diversified Markets for Low Quality Wood Products (Alternative 1-5), and to assist in the establishment of an Information and Education Program to Inform Landowners About Benefits of Forest Management (Alternative 1-6).

C. Farmers Home Administration Loans and Grants

The FmHA has a number of loan and grant programs designed to encourage the economic development of rural areas. These programs can be used by the region's rural communities to help implement alternatives.

Loans are available to assist sponsoring public agencies in Resource Conservation and Development Areas. Soil and water loans are designed

to aid farm landowners to make better use of their farmland. Watershed Protection and Flood Prevention loans help PL-566 sponsors to provide the local cost of structural measures. In addition, loans and grants are available to improve rural water systems.

Farmers Home Administration loans and grants could assist in implementing Alternatives 1-1, 2-2, 2-4, 3-2, and 6-2.

9.3 OPPORTUNITIES FOR OTHER PROGRAMS

A. Federal Programs

National Flood Insurance Program

The Department of Housing and Urban Development, through the Federal Insurance Administration, provides communities with the opportunity to participate in the National Flood Insurance Program. Flood insurance is available through local agents for residents of towns which qualify for the program. In return for federally subsidized insurance rates, the community must agree to consider flood hazards before approving development and to severely limit development of flood prone areas. All except ten of the Coastal Region communities are enrolled in the flood insurance program which implements Alternative 2-1, Flood Insurance.

Land and Water Conservation Fund

The Land and Water Conservation Fund administered by the U.S. Department of the Interior, Bureau of Outdoor Recreation provides cost sharing assistance to finance recreation and open space programs. The Fund could assist in implementing Alternatives 4-1 and 7-1.

Land Use

Recently enacted Chapter 780 of the Acts of 1977, Massachusetts General Laws, will be administered by the Division of Conservation Services working in cooperation with local Conservation Commissions. Starting with a pilot program, the Act will seek to halt the development of critical farmland through the purchase of development rights (Alternative 1-2).

The Horticultural Land Assessment Act under Chapter 61A of the General Laws can also be used in a multi-faceted approach to encourage the preservation of agricultural land use.

B. State Programs

Forestry Programs

The Department of Environmental Management, Division of Forests and Parks, cooperates with the U.S. Forest Service to assist forest landowners to make the best use of the forest resource. This program can aid in the implementation of Alternative 1-3, Increased Management of Forest Land, and Alternative 1-6, Information and Education to Inform Forest Landowners of Benefits of Management.

The Forestland Assessment Act, General Laws, Chapter 61, can be used to maintain forestland in the face of rising real estate taxes, thus, helping to implement Alternative 1-4, Increase Incentives to Manage Forest Land.

Wetlands Programs

The Wetlands Restriction Section of the Department of Environmental Management administers the Wetlands Restriction Act. Increased staff or greater use of outside consultants will be necessary if Alternative 4-2, Accelerate Wetlands Restrictions, is to be accomplished.

The Massachusetts "Wetlands for Wildlife" program of the Division of Fisheries and Wildlife has purchased wetland areas in the region for their wildlife habitat value. This program can be utilized to implement Alternative 4-1, Wetlands Acquisition. The Division of Conservation Services could assist municipalities to acquire and develop outdoor facilities through the Massachusetts Self-Help program.

Recreational Programs

The Department of Environmental Management, Division of Forests and Parks, is the agency which would be responsible for implementing the Massachusetts Scenic and Recreational Rivers Act (Alternative 7-3).

The department has established a pilot program for the North River to gain experience in administering the act.

Alternative 7-2, Establishment of Canoe Trails, could also be administered under ongoing programs of the Division of Forests and Parks.

The Massachusetts Self-Help Program can provide funds to assist in recreation and open space programs such as land acquisition to enhance environmental corridors (Alternative 7-1).

Reservoir Programs

The Division of Water Resources of the Department of Environmental Management has funds available from a bond issue to acquire and protect potential reservoir sites. These funds were utilized to investigate the feasibility of "Site #30-B" in Ipswich as a regional water supply reservoir. Funds may be available from this source to investigate and protect potential surface water reservoir sites (Alternatives 6-1 and 6-2).

The Massachusetts Self-Help Program can assist with acquisition of water supply sites and can also assist by acquiring conservation lands for future use as water impoundments (Alternative 6-2).

C. Regional Programs

Regional planning agencies are the logical group to assist communities to establish erosion and sediment control ordinances (Alternative 3-1).

Technical assistance and guidance is available from the Soil Conservation Service through the local Conservation District. A number of "model" ordinances are available which can be adapted to fit local conditions.

The Martha's Vineyard Commission has initiated a program to protect unique natural areas. Many of the Commission's programs relate directly to the enhancement and/or preservation of fragile, unique, or agricultural lands. On the Vineyard, the Commission's regulatory powers can be useful in implementing Alternatives 1-2, 3-1, 4-3, and 7-4.

ALTERNATIVE	DESCRIPTION	PROGRAM AND AGENCY													
1-2	Preserve Agricultural Land	Resource Conservation & Development (Lead USDA agency)													
1-3	Increase Forest Management	Soil Conservation Service	X												
1-4	Increase Forest Management Incentives	Soil Conservation Service													
1-5	Develop Diversified Timber Markets	Soil Conservation Service													
1-6	Establish Information and Education Program	Soil Conservation Service													
2-2	Structural Flood Protection	Soil Survey	X												
2-3	Flood Proofing	Soil Survey													
2-4	Structural & Flood Proofing	Soil Survey													
3-1	Erosion & Sediment Control Bylaws	Soil Conservation Service													
3-2	Critical Area Restoration	Soil Conservation Service													
3-3	Critical Area Restoration	Soil Conservation Service													
4-1	Wetlands Acquisition	Soil Conservation Service													
4-2	Accelerate Wetlands Restrictions	Soil Conservation Service													
4-3	Expand Conservancy Zoning	Soil Conservation Service													
5-1	Soil Survey	Soil Survey													
6-1	Investigate Potential Water Supplies	Soil Survey													
6-2	Acquire or Protect Water Supply Sites	Soil Survey													
7-1	Environmental Corridors	Soil Survey													
7-2	Canoe Trails	Soil Survey													
7-4	Protect Unique Natural Areas	Soil Survey													

Resource Conservation & Development (Lead USDA agency)

Soil Conservation Service

Soil Survey

Soil Conservation Service

PL-566

Soil Conservation Service

Natural Resources Planning Program

Soil Conservation Service

Renewable Resources Program

Forest Service

Loans & Grants

Farmers Home Administration

National Flood Insurance

Dept. of Housing & Urban Development

Forestry Programs

Dept. of Environmental Management

Wetlands Restriction Program

Dept. of Environmental Management

Recreation Programs

Dept. of Environmental Management

Wetlands for Wildlife

Dept. of Environmental Management

DWR Potential Reservoir Funds

Dept. of Environmental Management

Regional Planning Agencies

COASTAL REGION

APPENDIX A

Prime Potential Reservoir Sites

1. Summary

The potential reservoir sites which are presented in this appendix represent the prime possibilities for permanent water storage sites in the Coastal Region which are not already under active consideration for development. Topography, geology, and affected man-made facilities appear to be favorable. More detailed geologic and engineering investigations need to be made before sites are acquired. If future needs for a reservoir site in a particular area can be identified, steps should be taken to acquire the site at an early date so that development in the area does not make reservoir costs excessive. Early acquisition or protection of these potential reservoir sites is essential to conserve these important natural resources for future use.

2. Previous Studies

The Soil Conservation Service has completed and published inventories of potential reservoir sites in the Coastal Region. Reservoir locations were selected on the basis of suitable topography, relatively undeveloped pool areas, and certain drainage area, pool area, and storage characteristics. Inventory data which was prepared included a surficial geologic investigation, list of man-made facilities which would be inundated and preliminary designs and cost estimates for various levels of development.

The inventories provide a valuable source of basic information about more than 320 potential reservoir sites in the region. No attempt was made in the inventories to evaluate the potential of the sites for specific purposes such as water supply, recreation, etc. Unfortunately, many of the sites which first appear promising fail to meet the more stringent criteria required for a good water supply or low-flow augmentation reservoir. Among the more common problems are poor geologic conditions, recent development of the pool area, and extremely high cost.

3. Site Evaluation

The purpose of this appendix is the presentation of the most promising potential reservoir sites in the Coastal Region. Inventories of potential sites for the Ipswich, Neponset, Parker, North Shore, South Shore, Cape Cod, Buzzards Bay, Islands, Taunton, and Narragansett Bay Study Areas were used as the source of basic data. Many sites were quickly eliminated from

further consideration because of obvious problems connected with geologic conditions and extensive effects on man-made facilities. The relatively flat topography in the region also eliminated many sites; large shallow areas tend to produce poorer quality water supply than deep sites. Likewise, low-flow augmentation and recreation uses tend to favor the deeper pools. Several of the sites have already been selected for development and are in varying stages of planning, design, and construction. These include site "30B", the Beverly-Salem Water Board Reservoir and the Lynnfield Center Reservoir in the Ipswich Study Area; as well as the Diamond Brook reservoir in the Neponset Area.

The remaining sites were individually evaluated for potential uses. Table A-1 summarizes information for the sites which appear to have potential for permanent storage of water. More detailed information concerning the individual sites is available in the Inventory of Potential and Existing Reservoir Sites for the particular area.

4. Protection of Sites

These potential reservoir sites are an important natural resource. They are examples of unique situations combining suitable topography to provide efficient storage, good geologic conditions which limit excessive seepage losses, and relatively undeveloped, lower cost, reservoir areas. Many of the potential reservoir sites in Massachusetts have been lost for future utilization through poor or uninformed land use decisions. Residential and commercial development in the state has encroached on the potential reservoir area of a number of otherwise suitable sites. In many instances, wetland protection measures have been effective in preserving the stream and the adjoining wetlands. However, the higher nonwetland areas which would be needed to provide deep water storage potential have been subject to development with little restriction. As a result, a potential deep water storage site with good geology may be economically infeasible because of the high cost involved in removing encroaching development.

State and local governments must begin to recognize the importance of protecting this dwindling natural resource--the natural potential reservoir site--from loss through default. The result of inaction in this area will not be catastrophic. Loss of a potential reservoir site is a more subtle loss which may not become apparent for several years until needs for water supply or water-based recreation cannot be easily or economically met. Then it will become apparent that preservation of these sites would have been in the public interest. The purchasing of houses in a potential water supply reservoir is socially disruptive to a community as well as being highly expensive. Development in a potential recreation or fishing pool area usually represents the loss of the site as costs per surface acre become prohibitive. It would appear to be more prudent to establish a program of early acquisition of potential reservoir sites in order to safeguard the areas from development pressures.

A note of caution is necessary at this point. All of the data which has been prepared for the potential site inventories is based on preliminary data which should be substantiated and reinforced before site acquisition is undertaken. Among the most important items which need to be developed before acquisition is a detailed subsurface geologic investigation to ascertain the materials which are present. Analyses needs to be made of the potential for seepage into the ground water. Current appraisals of land costs by competent professionals are also needed.

If a future need for the site can be identified; and if the detailed studies show the site to offer practical potential, steps should be undertaken to limit unwise development of the area. Purchase of the site is one possibility. Acquisition of development rights is another. A third possibility might be donation of the land for conservation purposes by public-spirited citizens. Even if acquisition of a potential reservoir area does not appear feasible, governments can take steps to make development compatible with future use of the area. Highway locations can be realigned to skirt reservoir sites. Developers can be encouraged to keep potential pool areas as undeveloped green space to complement the developed areas. Town boards can avoid locating schools, sanitary landfills, and other municipal improvements on potential reservoir areas.

If steps are not taken to protect these potential reservoir sites from unwise or uninformed development, they will likely be too costly to acquire in the future. They will be lost for future reservoir use unless timely action is undertaken to protect and preserve them to meet anticipated needs.

TABLE A-1

PRIME POTENTIAL RESERVOIR SITES

Site	Town	Drainage Area (square miles)	Water Supply			Max. Depth (feet)	Low Flow			Augmentation for 120 days (cu.ft. per second)	Recreation	
			Elevation (mean Sea level)	Volume (million gallons)	Yield (million gallons per day)		Elevation (mean sea level)	Volume (acre-feet)	Elevation (mean sea level)		Area (acres)	
PA-0202	Newbury	0.54	--	--	--		27	240	1.0	27	30	
0307	Newbury	1.43	30	310	0.9	22	--	--	--	26	85	
0324	Georgetown	2.22	--	--	--		--	--	--	34	60	
0327	Rowley	1.42	--	--	--		40	240	1.0	40	50	
0328	Rowley	7.56	43	220	1.7	21	43	670	2.8	43	95	
0329	Rowley	0.70	--	--	--		46	290	1.2	45	40	
0330	Rowley	3.27	55	490	1.7	30	54	1,320	5.5	54	205	
0331	Rowley	13.10	25	120	1.6	15	--	--	--	25	100	
0333	Rowley	1.94	28	320	1.0	23	--	--	--	25	130	
0337	Rowley	5.80	57	180	1.3	13	57	550	2.3	57	75	
0509	Gloucester	0.58	--	--	--	17	--	--	--	142	35	
0606	Salem	1.54	25	140	0.6		--	--	--	25	70	
NE-1803	Sharon	0.72	--	--	--	17	--	--	--	264	30	
1907	Canton	1.73	182	250	0.9		182	760	3.2	181	105	
2005	Westwood	1.04	--	--	--		245	270	1.1	245	65	
IP-0411	N. Reading	1.00	102	1,200	P.S.1/	23	--	--	--	--	--	
0414	N. Andover	4.10	123	810	2.2		120	1,890	7.9	123	235	
0416	Middleton	1.60	102	950	P.S.1/	25	--	--	--	--	--	
0417	Middleton	10.70	73	820	3.3		73	2,510	10.6	73	340	
0419	N. Andover	1.50	182	420	0.9	20	175	640	2.7	178	95	
0423	Boxford	18.2	73	210	1.0	15	73	640	2.7	73	100	
0459	N. Andover	0.70	192	450	P.S.1/	13	181	310	1.3	178	45	

Levels of development presented in this table were selected to illustrate the maximum potential for each use.

Water supply is based on a safe yield of 0.6 million gallons per day per square mile of drainage area or the maximum safe yield of the site; whichever is less.

Low flow augmentation is based on 8 inches of runoff volume from the drainage area, or the maximum storage available at the site; whichever is less.

Recreation is based on the lesser of: the maximum surface area available at the site or, the surface area which is one-tenth of the drainage area size.

1/ This site has potential as a pumped-storage water supply facility. Safe yield will depend upon the source of pumped water, pumping period, land capacity of pumping equipment.

PRIME POTENTIAL RESERVOIR SITES

TABLE A-1

Site	Town	Drainage Area (square miles)	Water Supply			Low Flow		Recreation			
			Elevation (mean Sea level)	Volume (million gallons)	Yield (million gallons per day)	Max. Depth (feet)	Elevation (mean sea level)	Volume (acre-feet) (cu.ft. per second)	Elevation (mean sea (acres) level)	Area	
SS-2603	Hingham	4.40	70	360	1.4	20	70	1,090	4.6	70	130
2703	Norwell	1.57	82	290	0.9	16	--	--	--	82	105
88-4603	Westport	3.47	140	780	2.1	30	135	1,480	6.2	141	215
4604	Westport	3.34	73	700	1.9	41	--	--	--	73	140
IS-6904	West Tisbury	2.54	67	570	1.5	41	--	--	--	--	--
6905	West Tisbury	1.38	81	240	0.7	23	--	--	--	--	--
TA-4701	Easton	1.20	192	200	0.6	16	191	520	2.2	191	75
4804	Brockton	4.80	134	920	2.6	24	132	2,170	9.1	132	295
5401	Sharon	0.61	--	--	--	--	252	220	0.9	252	35
5407	Mansfield	1.29	--	--	--	--	192	250	1.1	192	50
5515	Wrentham	0.78	--	--	--	--	280	300	1.3	279	50
5516	Mansfield	19.46	152	280	1.6	20	152	860	3.6	152	200
5601	Norton	1.50	--	--	--	--	92	150	0.6	92	35
5802	Freetown	3.31	148	710	2.0	26	143	1,190	5.0	150	220
5804	Freetown	3.80	111	840	2.3	41	104	1,620	6.8	117	245
5805	Freetown	4.06	82	270	1.1	47	82	810	3.4	82	65
NB-5902	Rehoboth	5.26	108	1,100	3.0	36	103	2,100	8.8	107	330
5909	Rehoboth	5.77	70	910	2.8	26	69	2,350	9.9	70	365
6004	N. Attleborough	2.39	203	530	1.4	27	199	1,070	4.5	205	160
7204	Swansea	0.77	--	--	--	--	126	300	1.3	125	55
7205	Swansea	1.48	92	170	0.6	28	92	530	2.2	92	45
7206	Swansea	2.11	82	610	1.5	34	74	980	4.1	82	135
7207	Swansea	7.62	81	790	2.8	15	81	2,440	10.3	81	480
7208	Dighton	0.69	--	--	--	--	115	260	1.1	113	45

APPENDIX B

This section contains the criteria used to evaluate major wetlands in the Coastal Region. Each of the 85 wetlands which was evaluated was subjected to map study and a field examination. Ratings were assigned based on point values obtained for various attributes. Rationale for each evaluation item is also contained in this appendix to explain the background concerning development of the criteria.

The wetland evaluation criteria were developed by an interdisciplinary team of USDA specialists. Draft criteria were circulated among federal, state and regional agencies for comments and suggestions.

The criteria, with modifications, may be helpful in assessing the smaller wetlands of a community. Development of the evaluation procedure was based upon a regional approach and certain criteria, such as size, may need to be altered to fit local situations. The numerical rating values might also need to be modified to account for factors which might be important from a local basis but insignificant on a regional scale.

WETLAND EVALUATION

Wetland Name _____ No. _____ Date _____

Wetland Location (City or Town) _____

Investigator _____

Ownership (Public - give name; or Private) _____

Size (acres) _____ Drainage System _____

Type Classification (acres per type) _____

Surrounding Topography _____

Flora _____

Fauna _____

Current Use _____

Adjacent Land Use _____

Nearness to Houses, etc. _____

Potential Pollution Problem _____

Accessibility _____

Potential Storage Depth at Outlet _____ ft. (vertical distance from normal water level to top of control structure)

Size of outlet structure if any _____

Rating Summary

Forest Management _____ Recreation _____

Flood Control _____ Uniqueness _____

Fish Habitat _____ Visual Quality _____

Wetland Wildlife Habitat _____

Comments

WETLAND EVALUATION

Wetland Name _____ No. _____

FOREST MANAGEMENT 1/

CRITERION	RANGE	Circle Correct RATING
1. Public ownership of forested wetland	>30% 15-30% <15%	3 2 1
2. Stand size class distribution 2/ (sawtimber, poletimber, seedling-sapling)	<80% in any 2 classes >80% in any 2 classes >80% in any 1 class	3 2 1
3. Portion of forestland with 81-100% crown closure	>80% 30-80% <30%	6 4 2
4. Portion of wetland forested	>60% 30-60% <30%	3 2 1
5. Predominant forest cover type	Cedar, red maple, larch/ tamarack or green ash Hemlock, black ash or black spruce	9 3
6. Shape of forested wetland	Block Long narrow strip	3 1
7. Type of soil	Mineral Peat	6 2
8. Accessibility	Roads in wetland Roads leading to but not in wetland No roads leading to wetland	6 4 2
Total circled items: _____		

RATING: Greater than 28 = High
24 to 28 = Moderate
Less than 24 = Low

Rating is: _____

1/Wetlands containing less than 5 acres of forest should not be rated.
Insert NR in rating blank.

2/ If wooded areas are inaccessible for inspection MacConnell's height classes may be used:

Classes 1 & 2 Seedling-Sapling
Classes 3 & 4 Poletimber

Class 5 Sawtimber
Class 6 - rates high (3)

WETLAND EVALUATION

Wetland Name _____ No. _____

FLOOD CONTROL

CRITERION	RANGE	Circle Correct RATING	
1. Effective storage of wetland on total watershed above.	<1" runoff		0
	1"-3" runoff		6
	>3" runoff		9
2. Effective storage of upstream reservoirs and wetlands on total watershed.	<1" runoff		3
	1"-3" runoff		2
	>3" runoff		1
3. Effective storage on main stem between wetland and Potential Damage Area or major confluence.	<1" runoff		8
	1"-3" runoff		4
	>3" runoff		0
4. Distance downstream to Potential Damage Area	<1 mile		3
	1-5 miles		1
	over 5 miles		0
5. Severity of Potential Flood Damage (downstream)	<3 miles	Low	2
		Moderate	4
		High	8
	or 3-5 miles or below major confluence	Low	1
		Moderate	2
		High	4

Total circled items: _____

RATING: Total is: Less than 15 = Low
 15 to 23 = Moderate
 24 or greater = High RATING is: _____

WETLAND EVALUATION

Flood Control

Instructions for Each Item on the Evaluation Sheet

1. The effective storage can be estimated by expected increase in wetland water elevation (a) during a large (approx. 100 year) flood times (x) the wetland area times (x) 12 divided by the drainage acres.

$$\text{Effective Storage} = \frac{\text{Change in elevation x wetland area x 12}}{\text{(in inches runoff) drainage acres}}$$

(a) Where there is a control at outlet of wetland, change in elevation will be estimated by field observation. Where there is no control, use attached curves.

2. Effective storage of upstream reservoirs and wetlands is estimated as under Item 1 and includes all storage in the drainage area above the wetland being evaluated, but not the wetland storage.
3. Effective storage on the main stem below the wetland being evaluated and the major part of the damage area. This is the storage of the downstream channel or wetland (inches) divided by the total drainage above the damage area (acres).
4. This is a visual estimate using aerial photos, quad sheets, personal knowledge or observation.
5. This is to be a comparison rating based on aerial photos, quads, personal knowledge and observation. Damage which might occur to that which replaces and surrounds the wetland should also be considered.

Potential Damage: Low - agriculture, scattered residences, secondary roads

Moderate - >low but <high

High - concentrated residences, commercial, industrial, primary roads.

Limitation of Wetland Rating

The following system of evaluating wetlands as to their effectiveness in controlling floodwaters categorizes the wetland as: low, medium or high. No attempt should be made to compare wetlands within a category on the sole basis of the numerical rating.

Procedure for Wetland Evaluations

1. Use one sheet for each wetland.
2. Begin at upper end of drainage and work downstream.
3. The downstream wetland of two wetlands in series should be partially completed before rating the upper wetland.

Wetland or Other Control	Drainage (ac.)	Storage (ac./ft.)	Storage (in.)	Upstream Storage (ac./ft.)	Storage (in.)	Downstream Storage (ac./ft.)	Storage (in.)
-----------------------------	-------------------	----------------------	------------------	-------------------------------	------------------	---------------------------------	------------------

This table is to be completed on drainages with more than one wetland.
Wetland areas should be listed working downstream.

WETLAND EVALUATION

Wetland Name	No.
--------------	-----

FISH HABITAT 2/

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Principal wetland type 1/	5	4 (with some type 5 present)	Other
2. Size (acres of Type 5) 1/	50+	>25 but <50	<25
3. Location of wetland	Immediately adjacent to a lake which supports warm water fish.	Immediately adjacent to a perennial stream that supports warm water fish.	Adjacent to intermittent stream or cut off from streams.
Presence of fish cover	Abundant	Limited	Scarce

Presence of game fish (number of species present)	2 or more	1	None
--	-----------	---	------

Total number of items circled in (a) (b)

Calculation:

No. circled in column (a) \times 2 + no. circled in column (b) \times 1 = _____

RATING: Total is: 8 to 10 = High
 5 to 7 = Moderate
 0 to 4 = Low

RATING IS:

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

2/ There must be some type 5 present to evaluate the wetland for this use. If not rated insert NR in rating blank.

WETLAND EVALUATION

Wetland Name _____ No. _____

WETLAND WILDLIFE HABITAT

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Principal wetland type 1/	3 or 4	5, 6 or 7	1, 2 or 8
2. Number of wetland types 1/	3 or more	2	1
3. Diversity of adjacent land use (other than urban types) 2/	3 or more	2	1
4. Percent of perimeter with 300'+ wide buffer strip 3/	80%+	60%+ but <80%	<60%
5. Size (acres)	200 or more	100+ but <200	<100
6. Islands	Yes	---	No
Total number of items circled in:	(a) _____	(b) _____	

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING: Total is: 9 to 12 = High
 5 to 8 = Moderate
 0 to 4 = Low

RATING IS: _____

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, United States Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

2/ The following types will qualify for the diversity determination:
1 type - forestland (any or all type(s) present will collectively constitute the equivalent of one diversity type)

1 type - unused tillable (TU), pasture (T), orchard (O)

1 type - abandoned field (AF), abandoned orchard (AO)

1 type - sand or gravel removal (SG) (inactive)

1 type - recreation land--any one or more of the following types:

RG - golf course, RD - golf driving range, RSK - ski area,

RFG - fairground, RP - urban park

3/ Buffer strip = area adjacent to wetland perimeter without occupied buildings or other urban uses.

WETLAND EVALUATION

Wetland Name _____ No. _____

RECREATION

Circle the correct rating for each line entry.

	(a) <u>High</u>	(b) <u>Moderate</u>	(c) <u>Low</u>
<u>BOATING:</u> (Pleasure and Fishing - canoe and flat bottom)			
1. Principal Wetland Type used for boating (4 or 5)	5	4	All others
2. Acres available (per continuous wetland 4 & 5)	100+	>50 but <100	<50
3. Physical Access (No. of Access Points)	2+	1	0
4. Boatable Stream Present	(enters and leaves wetland)	(enters or leaves wetland)	none present

FISHING: (shoreline)

5. Principal Wetland Type used for fishing (4 or 5)	5	4 (with some type 5 present)	other
6. Wetland Size (acres)	50+	>25 but <50	<25
7. Physical Access--shore Percent of shoreline from which fishing is available	20%+	5%+ but <20%	<5%

NATURE STUDY:

8. Diversity of plants and animals (number of types)	3 or more	2	1
9. Percent of urban development within 300 feet of wetland perimeter.	<5%	5% to <25%	25%+

HUNTING:

10. Waterfowl hunting - amount of Type 3, 4 and 5	100 acres+	25+ but <100	<25 acres
11. Access for hunting	Unlimited	Permission of landowner required	None available

Total number of items circled in (a) _____ (b) _____

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING: Total is: 16 to 22 = High
 9 to 15 = Moderate
 0 to 8 = Low

RATING IS: _____

WETLAND EVALUATION

Wetland Name _____ No. _____

UNIQUENESS

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. Location - wetland surrounded by:	Intensely urban	Suburban	Rural
2. Wetland supports a threatened, endangered, or uncommon species of plant or animal	A threatened or endangered species	An uncommon species	None
3. Wetland contains a regionally rare plant community 1/	Yes	--	No
4. Wetland attracts a regionally significant number of migrating birds	Yes	--	No
5. Wetland is archaeologically, geologically or historically significant	Yes	--	No
6. Size: (acres)*	500 acres and more	200 acres or more but <than 500 acres	< 200 acres

Total number of items circled in: (a) _____ (b) _____

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING: a. Any item 2-6 rating high = High
b. Total is: 3 to 6 = Moderate
0 to 3 = Low

RATING IS: _____

1/ Occurs less than 5% of the time in inventoried wetlands.

* Uniqueness due to size may need evaluation by region in Massachusetts. The north and southeastern sections of the state have wetland areas qualifying (under for the above categorization; Western and Central Massachusetts should be re-evaluated in terms of overall wetland size.

WETLAND EVALUATION

Wetland Name: _____ No. _____

VISUAL QUALITY

Circle the correct rating for each line entry.

	(a) High	(b) Moderate	(c) Low
1. One or more public roads enables travelers to overlook the wetland at	3+ different locations or 1 mile or more	2 different locations or 1/4 mile+ but <1 mile	1 location or <1/4 mile
2. Overlooks accessible by-path or trail	2 or more overlooks accessible	1 overlook accessible	No overlooks accessible
3. Wetland contains some type 7 wetland consisting of deciduous woodland	75+ acres of red maple	40+ but <75 of red maple	<40 acres
4. Surrounding topography provides potential for developing overlooks	Potential for 2 or more different overlooks	Potential for 1 overlook	No potential for an overlook
5. Wetland contains an island	Yes	---	No
6. Appearance and condition	Undisturbed and natural	Somewhat disturbed and littered	Messy, littered filling, junky
7. Wetland types	Wetland contains some visible Type 4 or 5	Wetland contains some Type 2 or 3	Wetland contains no visible Types 2, 3, 4 or 5

Total number of items circled in (a) _____ (b) _____

Calculation:

No. circled in column (a) x 2 + no. circled in column (b) x 1 = _____

RATING:

Total is: 10 to 14 = High

5 to 9 = Moderate

0 to 4 = Low

RATING IS: _____

Rationale - Forest Management

CRITERION 1 - PUBLIC OWNERSHIP

Publicly owned forestland is more prone to multiple use management which includes wood fiber production as one of the uses.

CRITERION 2 - STAND SIZE CLASS DISTRIBUTION

The optimum size class distribution is 50 percent sawtimber, 25 percent poletimber and 35 percent seedling-sapling. Sawtimber trees are live trees of commercial species that have the following minimum diameters at breast height--softwoods 9.0 inches and hardwoods 11.0 inches. Poletimber trees are live trees of commercial species at least 5.0 inches in diameter at breast height but smaller than sawtimber size. Seedling-sapling trees are live trees of commercial species with diameters at breast height of less than 5.0 inches.

CRITERION 3 - STAND DENSITY

Optimum wood fiber production is achieved when the stand is fully stocked. One measure of stocking is the amount of crown closure. The greater portion of the forest that is at or near full stocking, the higher the potential for wood fiber production.

CRITERION 4 - PORTION OF WETLAND FORESTED

The greater the amount of the wetland forested, the greater the potential for wood fiber production, and the greater the incentive for the landowner to manage the land for forest products.

CRITERION 5 - FOREST COVER TYPE

The forest cover type of any area is determined by the principal species present. Cedar, red maple, larch/tamarack or green ash are the cover types that have the highest value for wood fiber production. Management of these types would be the most profitable.

CRITERION 6 - SHAPE OF FORESTED WETLAND

A block of forestland of some regular shape is more conducive to management than a long narrow strip of forestland, as might be found along a waterway.

CRITERION 7 - TYPE OF SOIL

The volume of wood that can be grown on a site is directly related to the soil. Peat soils generally produce wood fiber at a much slower rate and poorer quality than mineral soils.

CRITERION 8 - ACCESSIBILITY

Forestland that has roads to and through it is more conducive to management because road construction is one of the major expenses of forest management.

Rationale - Flood Control

To evaluate wetlands for their value in flood control three basic factors are considered, these are: (1) the actual storage, (2) the effectiveness of that storage, (3) the existing need for control downstream (damage potential).

1. The effective storage of a wetland in relation to its drainage area is the single most important factor in flood control. As the inches of runoff storage increases, the more significantly are flows extended over a longer period of time, thus reducing the peak flows from any given storm.
2. Effective upstream storage by reservoirs and other wetlands may already be controlling the flows to the extent that the storage in question may have little effect, even though it has a very effective storage volume.
3. Main stem storage upstream of a potential damage area can have the same effect on peak flows as another wetland. Also, small streams entering a large stream generally have a significantly reduced effect on flows below that point.
4. The effect of a wetland decreases as you move downstream from it. This is because of two things, first, the routing effect of the stream channel and flood plain itself and secondly, as you move downstream the drainage area becomes progressively larger and the considered wetland has less effect.
5. The value or importance of a wetland for flood control is reduced if there is little or no potential for damage downstream regardless of how effective it may be.

Rationale - Fish Habitat

Principal Wetland Type - Type 5 is the only freshwater wetland type that can support fish in all seasons. Type 4 is suitable in spring and fall, but some Type 5 must be present to maintain fish during summer and winter.

Size - The larger the wetland the more fish it will physically support. One hundred acres was considered necessary to rate high in a regionwide inventory.

Location of Wetland - Wetlands are often used for spawning habitat by warm water species of fish. Some species of fish (e.g., golden shiner, chain pickerel) require aquatic vegetation for spawning sites. Warm water lake fishery is dependent on wetland acreage for spawning sites, nutrient inflow, and as young fish rearing areas. Perennial streams supporting warm-water fish benefit from wetlands, but generally less so than lakes. Intermittent streams do not support substantial fishery.

Presence of Fish Cover - Warm-water fish require logs, stumps, pond lilies, watershield, etc. for protective cover. If the wetland surface is covered with 35 percent or more with stumps, lilies and other plants, it will have a rating of abundant; 10 percent or more, but less than 35 percent will rate as moderate; less than 10 percent as scarce.

Presence of Game Fish - If the wetland is included in "An Inventory of the Ponds, Lakes and Reservoirs of Massachusetts" by James A. McCann (published by Water Resources Research Center, University of Massachusetts) and has a specified productivity of 60 or more pounds of fish per acre, the rating will be high. If listed productivity is 40 or more, but less than 60, the rating will be moderate. If listed productivity is less than 40 pounds per acre, the rating will be low.

If the wetland is not included in "An Inventory of the Ponds, Lakes, and Reservoirs of Massachusetts," then the rating will be based on the following:

High rating - 2 or more species of game fish are present

Moderate rating - 1 species of game fish is present

Low rating - no species of game fish is present.

Game fish shall be limited to brook trout, brown trout, largemouth bass, chain pickerel, and northern pike.

Rationale - Wetland Wildlife Habitat

These criteria were developed to rate wetlands for wetland wildlife habitat. Species in this category include shorebirds, waterfowl, herons, bittern, beaver, muskrat, otter, and associated songbirds (e.g., yellow warbler, tree swallow, red-winged blackbird, marsh wren, kingfisher, etc.).

Principal Wetland Type - For wetland wildlife Types 3 and 4 1/ were considered the most valuable. In the northeast 3/4 or more of the Type 3 and 4 wetlands are classified of prime importance to waterfowl. These types are also of high value to the other forms of wetland wildlife itemized above. Types 5, 6 and 7, although not providing as great a diversity of plant life, are of moderate value to wetland wildlife.

Types 1, 2 and 8 are either only infrequently wet or support a very limited diversity of plants (bogs).

Although all wetland types provide habitat for certain species of wildlife, the criteria emphasizes those types with permanent water for the wetland wildlife rating.

1/ Wetlands of the United States, Circular 39, U.S. Department of the Interior, 1971.

Number of Wetland Types - The greater the number of types in a single wetland the greater will be the diversity of flora and fauna in that wetland. Diversity is a common parameter for measuring quality.

Diversity of Adjacent Land Use - Adjacent land uses provide additional feeding or nesting sites for many of the wetland wildlife species.

Buffer Strip - A 300 foot wide or greater buffer strip without occupied buildings or other intensive uses will serve to protect the amenities of the wetland. Buffer strips provide nesting habitat for many species of wetland wildlife. Seventy-five percent of all duck nests are found within 300 feet of water. Nests are seldom found closer than 100 feet of buildings.

Size - A minimum wetland size was necessary to prevent excessive expenditures of time on the wetland inventory portion of the river basin studies. The minimum size varies in different regions of the state depending upon the number and size of wetlands present. It is the intent of the inventory to include only the more significant wetlands in each region, however, smaller wetlands of regional significance may be included.

Islands - Islands provide a preferred nesting site of the mallard, teal and black duck. Islands offer natural protection from predators reluctant to travel over water to reach the island.

Islands also usually provide a diverse vegetative condition especially when the island elevation exceeds 3 feet above the normal water elevation of the wetland.

Rationale - Recreation

These criteria were developed to rate the value of a wetland for canoe or flat bottom boating, fishing, nature study and hunting. These were considered to be the primary recreation activities conducted on wetlands.

Boating

Principal Wetland Type - Type 5 (inland open Freshwater) consists of open water up to 10 feet deep and because it is deep was rated the best suited for boating use.

Type 4 was rated as moderate value for boating because its depth ranges from only 6 inches to 3 feet and it supports a substantial amount of emergent and floating aquatic plant growth.

All other wetland types were considered unsuitable for boating because of: lack of standing water or dense vegetation.

Acres Available - The more boatable water available, the more desirable the boating activity. Continuous wetland means that the wetland inventoried is either one single wetland or is two or more boatable wetlands linked by a boatable stream.

Physical Access - Physical access means that it is convenient to launch a canoe or flat bottom boat without excessive carrying distances or without having to push the craft out through dense woody vegetation to reach open water.

Boatable Stream Present - Access is facilitated and it is more desirable if a boatable stream enters, crosses and leaves a wetland area.

Fishing

Principal Wetland Type - Type 5 is the only wetland type of sufficient depth to support fish during all seasons. Type 4 will support fish in spring and fall but there is likely to be oxygen deficiencies in summer and winter, therefore, the presence of some Type 5 is essential.

Size - The larger the wetland the more attractive it is for fishing and the more fish will be supported. One hundred acres or more in size was considered necessary to rate high in a regionwide inventory.

Physical Access - Shore - Many persons, particularly children desiring to fish do not have boat equipment and their fishing is limited to the shoreline. Some open shoreline free of woody plants and dense herbaceous plants is necessary for casting.

Nature Study

Diversity of Plants and Animals - Each wetland type supports a variety of wetland flora and fauna. The greater the number of wetland types present in the wetland the greater will be the diversity of flora and fauna. The more diversity present the better will be the nature study opportunities.

Wetland Perimeter - Urban development in the 300 foot wide strip would detract from the nature study values of a wetland (noise, pollutants, litter, domestic animals, trail bikes, etc.).

Hunting

Waterfowl Hunting - Types 3, 4 and 5 are the most attractive wetlands for waterfowl and consequently for waterfowl hunting. Although any size wetlands of these types will attract waterfowl, a 100 acre plus wetland was considered to be significant on a regionwide basis.

Access for Hunting - Hunting is only possible where permitted by the landowner or governing agent.

Rationale - Uniqueness

Location of Wetland - There are few situations where wetlands are located in intensely urbanized areas. Where this is the case, the wetland provides many people with the opportunity to observe or study the diverse flora and fauna within the wetland. Close proximity to schools offers the potential for formal study by school biology and earth science classes.

Threatened, Endangered or Uncommon Species - Science is as yet ignorant of the net results of a species being exterminated and until mankind becomes this sophisticated in his knowledge of the natural environment we had best tread lightly. The diversity of species is an indicator of environmental quality and when the diversity is reduced the environmental quality is likewise reduced. Man is a part of the natural environment and must co-exist with other species in this natural environment.

Migrating Birds - Offers the public an opportunity to see unusual wildlife concentrations.

Archaeologic, Geologic or Historic Significance - This determination will be sought from local, regional and state authorities (e.g. State Historical Society, Regional Planning Authority).

Size - Any wetland greater than 200 acres in size is uncommon in the Commonwealth of Massachusetts.

Rationale - Visual Quality

The visual quality of a wetland is largely dependent upon the wetland's openness and available access from which people can view it. Wetland Types 1/ 2, 3, 4, and 5 are the more open types which people can look at.

Roads around or through a wetland enable people to look out over the wetland even though they don't care to walk into its interior. For those persons wanting to see a wetland, paths or trails facilitate access.

Islands add to the diversity of flora within a wetland and, therefore, contribute to the wetland's visual quality.

Litter detracts from a wetland's appearance and, therefore, absence of litter is a positive factor.

1/ Wetland type pertains to those described in Wetlands of the United States, Circular 39, U.S. Department of the Interior, Fish and Wildlife Service, United States Government Printing Office, Washington, D.C., 1971.

APPENDIX C

Public Lakes, Ponds and Reservoirs

Prepared by the Massachusetts Division of Water Resources

The purpose of this phase of the study is to compile a comprehensive listing of public ponds, lakes and reservoirs relative to size, access, flowage rights and ownership, as well as water and shoreline use. The Massachusetts Water Resources Study principals have come to realize that the ownership of our water resources is a question of paramount importance to the public.

Current information on water body status as a public or private resource is often incomplete, inaccurate or out-of-date. Within the framework of this study, the Massachusetts Division of Water Resources found the appropriate opportunity to gather some new information. It is planned that this survey will be continued eventually to cover the entire state and made part of a permanent record system.

At the study's outset, available existing information was used heavily to produce a rough, preliminary working list. Sources used included Department of Public Works (DPW) and Department of Environmental Quality Engineering (DEQE) records, the University of Massachusetts County Lakes, Ponds and Reservoirs Inventories by McCann, et al., in addition to earlier studies conducted by the Division of Fisheries and Wildlife. These sources produced an extensive working list refined according to certain criteria to establish eligibility for the final listings.

A primary objective of this survey is to identify water bodies which should be available for public use. It was found that certain waters could be eliminated quickly. Except for municipally-owned reservoirs over twenty acres with recreational access, and water bodies within state or federally owned land, natural ponds under ten acres and wholly man-made reservoirs were excluded. As a result of applying these criteria, only ponds, lakes and reservoirs of apparent public status and significance remain on this final listing for the Coastal Region.

It should be noted that the designation of "apparent public or great pond status" does not preclude the occurrence of private ownership of some of the water bodies so labeled. However, this classification should signal the need for a full survey pursuant to Chapter 91 or 131 of the General Laws to clear up any remaining question of status on water bodies within this category. When a pond's public status has been ascertained, access can be provided by the Massachusetts Public Access Board acting pursuant to the authority contained in Section 17 of Chapter 21 of the Massachusetts General Laws.

Basic Facts Regarding Great Ponds as Provided by the Colony
Ordinance of 1641-7 and its Interpretations

Size

Great Ponds are those over ten acres, except regarding fishing where rights exist in ponds over twenty acres.

Ownership

Pond bottom is owned by the state below the ordinary low water mark.

Rights

Use by the public, so long as one does not trespass on a man's "corn or meadow." A right also exists to seek the provision of a public access to avoid such trespass.

Uses

Fishing, fowling, boating, bathing, skating or riding upon the ice, taking of water for domestic or agricultural purposes, or for use in the arts and the cutting and taking of ice.

Enlarged Great Ponds

Public rights exist in the entire waters of an enlarged natural great pond. In discussing this, Massachusetts Water Laws (1970) states:

"A reflection upon all of the cases which have been reviewed seems to establish conclusively that all public rights in natural great ponds...can be lawfully exercised in any part of the waters which are impounded by dams erected at the outlet of great ponds containing more than ten acres, except the public right of fishing, which right will be restricted to natural great ponds exceeding twenty acres in size."

By checking records of the county engineer and by comparing the heights of dams with depth data, many enlarged great ponds can be identified. Even with such research and onsite inspections, some water bodies could not definitely be assumed to be great ponds. Formal surveys by the Waterways Division could ascertain their status.

It should be noted that this list is not, therefore, official. It represents our best judgment, bearing in mind that exact measurements are required in borderline cases. The problem of great pond identification is most difficult where an original natural pond has been enlarged by the construction of a dam at its outlet.

The significance of the study is manyfold. It indicates those ponds where the right of public access exists and can be developed under existing law.^{1/} It also suggests that other lakes not listed are currently private. Where important private water bodies exist, public funds might be expended to obtain usage rights where appropriate.

^{1/} Caveat--No right exists to walk along privately-owned shorelines once access is obtained. Public access rights may also be denied by the local water authority where a pond is withdrawn for water supply. Uses may be regulated by towns and state agencies, as authorized by statute.

PARKER STUDY AREA COMMUNITIES

1. Georgetown
 Pentucket Pond #5-5-105-1* (PA-3)+ 84 Acres
 An enlarged great pond identified by the Division of Waterways (DEQE). No formal public access has been provided. Informal access has been obtained from Pond Street by the Division of Fisheries and Wildlife, which presently maintains a fish stocking program. Flowage is with the Town of Georgetown.
 Rock Pond (PA-3) 57 Acres
 A natural great pond that has been surveyed by the Division of Waterways (DEQE). Formal public access has been obtained and developed by the Massachusetts Public Access Board.
2. Groveland
 Crane Pond (PA-3) 20 Acres
 An apparent natural great pond. Informal public access is available across The Crane Pond Area of the Massachusetts Division of Fisheries and Wildlife.
 Johnsons Pond #5-5-116-7 (ME-20) 208 Acres
 An enlarged great pond, part of the water supply for the City of Haverhill. It has been surveyed by the Division of Waterways (DEQE).
3. Newbury
 No lakes, ponds, or reservoirs which meet criteria.
4. Newburyport
 No lakes, ponds, or reservoirs which meet criteria.
5. Rowley
 No lakes, ponds, or reservoirs which meet criteria.

* Massachusetts Division of Waterways Dam Inspection File Identification Number.
 + Soil Conservation Service, USDA subwatershed designation.
 (CH) Charles Drainage (IP) Ipswich Drainage
 (ME) Merrimack Drainage (NE) Neponset Drainage
 (NS) North Shore Drainage (PA) Parker Drainage

IPSWICH STUDY AREA COMMUNITIES

1. Boxford
 Baldpate Pond (PA-3) 66 Acres
 A natural great pond surveyed by the Division of Waterways (DEQE). Informal access from state land in The Georgetown State Forest.
 Chadwick Pond (ME-20) 161 Acres
 An apparent great pond that has been withdrawn for water supply purposes by the City of Haverhill.
 Crooked Pond (IP-4) 6 Acres
 A small natural pond which constitutes public waters contained in the Boxford Wildlife Sanctuary. Access can be gained across the Sanctuary. Fishing is allowed.
 Four Mile Pond (IP-4) 54 Acres
 A natural great pond. No formal public access has been provided. The pond has been identified by the Division of Waterways (DEQE).
 Hoveys Pond (ME-20) 38 Acres
 A natural great pond that has been withdrawn for water supply for the City of Haverhill. It is presently closed to public use. It has been surveyed by the Division of Waterways (DEQE).
 Spoffords Pond (IP-4) 27 Acres
 A natural great pond that has been identified by the Division of Waterways (DEQE). No formal public access has been provided.
 Stevens Pond (IP-4) 12 Acres
 A natural great pond identified by the Division of Waterways (DEQE). No formal public access has been provided.
 Stiles Pond #5-5-38-3 (IP-4) 60 Acres
 An apparent enlarged great pond. No formal public access has been provided. Flowage rights are with Chester K. Twist of Boxford.

2. Hamilton

Beck Pond (NS-5)

36 Acres

A natural great pond identified by the Division of Waterways (DEQE). No formal public access has been provided.

Chebacco Lake (NS-5)

209 Acres

A natural great pond. Access has been developed by the Public Access Board. The lake has been surveyed by the Division of Waterways (DEQE).

Gravelly Pond (NS-5)

45 Acres

A natural great pond that has been withdrawn by the Town of Manchester for water supply. It is closed to public recreational use.

Pleasant Lake (IP-04).

43 Acres

A natural great pond that has been surveyed by the Division of Waterways (DEQE). There is no formal public access.

Round Pond (NS-5)

38 Acres

A natural great pond, surveyed by the Division of Waterways (DEQE) that has been withdrawn by the Town of Manchester for water supply. The pond is presently closed to any public recreational use.

3. Ipswich

Clark Pond (PA-3)

27 Acres

An apparent natural freshwater great pond. No formal public access has been provided.

Hood Pond (IP-4)

67 Acres

An apparent natural great pond. Informal access is available through the Willowdale State Forest. The pond is used for recreation.

Willowdale Bog Pond (IP-4)

4 Acres

A shallow public pond, excavated in the extraction of bog iron, on state land in the Willowdale Forest. Informal access is available across the forest.

4. Middleton

Middleton Pond #5-5-184-6 (IP-04)

135 Acres

An enlarged apparent great pond. Access is controlled by the local water authority since it is withdrawn for water supply for Middleton and the City of Danvers. The reservoir is not currently used for recreation, and flowage is with the City of Danvers.

5. North Andover

Berry Pond (IP-04)

4 Acres

A small natural pond. Informal public access is across state land in the Harold Parker State Forest. These public waters are used for recreation.

Lake Cochichewich #5-5-210-6 (ME-20)

592 Acres

An enlarged apparent great pond used as water supply by the Town of North Andover. No public access has been provided. Flowage rights are with the Town of North Andover. The pond is presently closed to public recreational use.

Salem Pond (IP-04)

18 Acres

Artificially created public waters. Access for recreation is through the Harold Parker State Forest which encompasses the pond.

Stearns Pond (IP-04)

46 Acres

An artificial pond on state land in the Harold Parker State Forest. Informal access is available across the forest to these public waters which are used for recreation, including swimming.

Sudden Pond (IP-04)

6 Acres

A small natural pond. Access to the public waters is through the Harold Parker State Forest of which this pond is a part. The pond is used for recreation.

6. North Reading

Bradford Pond (IP-04)

14 Acres

An artificial pond located on state land in the Harold Parker State Forest. Informal access to these public waters can be gained through the State Forest. The pond is used for recreation.

6. North Reading (continued)

Martins Pond (IP-04)

92 Acres

A natural great pond. Access to the public waters identified and obtained by the Division of Waterways (DEQE).

Swan Pond (IP-04)

45 Acres

An apparent great pond. The waters have been withdrawn for water supply purposes for the City of Danvers. The pond is not presently used for public recreation.

7. Reading

No lakes, ponds or reservoirs which meet criteria.

8. Topsfield

No lakes, ponds or reservoirs which meet criteria.

9. Wenham

Coy's Pond (NS-5)

25 Acres

A natural great pond, identified by the Division of Waterways (DEQE). No public access has been provided.

Longham Reservoir #5-5-30-3 (IP-04)

47 Acres

An artificial municipal water supply reservoir. Flowage rights are with the Salem-Beverly Water Supply Board. The reservoir is currently closed to any public use.

Wenham Lake (IP-04)

220 Acres

An enlarged apparent great pond. Water is withdrawn for water supply for the cities of Beverly and Salem. Flowage is with the Salem-Beverly water supply board. The lake is presently closed to public recreational use.

10. Wilmington

Silver Lake (IP-04)

28 Acres

A natural great pond. Informal access can be obtained from State Highway #38.

Fosters Pond (ME-19)

135 Acres

(See Andover)

NORTH SHORE STUDY AREA COMMUNITIES

1. Beverly

Beaver Pond (IP-04)

16 Acres

An apparent great pond for which no public access has been provided.

Longham Reservoir #5-5-30-3 (IP-04)
(See Wenham)

47 Acres

Norwood Pond #5-5-30-2 (IP-04)

45 Acres

A publicly-owned artificial pond. Informal public access can be obtained through state land owned by the Massachusetts Board of Regional Community Colleges. Flowage rights are with this agency.

Wenham Lake (IP-04)

220 Acres

An enlarged apparent great pond. Withdrawn for water supply for the cities of Beverly and Salem. Flowage is with the water authority. The pond is presently closed to recreational use.

2. Chelsea

No lakes, ponds or reservoirs that meet criteria.

3. Danvers

Putnamville Reservoir (IP-04)

266 Acres

An artificial municipal water supply reservoir. Fishing is presently permitted. Flowage is with the Salem-Beverly Water Board.

4. Essex

Chebacco Lake (NS-5)

209 Acres

A natural great pond identified by the Division of Waterways (DEQE). Formal public access has been acquired by the Division of Waterways (DEQE) and by the Public Access Board to the public waters of this pond.

5. Everett

No lakes, ponds or reservoirs that meet criteria.

6. Gloucester

- Babson Reservoir #5-5-107-17 (NS-5) 27 Acres
An artificial reservoir; part of the water supply for the City of Gloucester. It is presently closed to public use. Flowage is with the Gloucester Water Department.
- Dykes Pond #5-5-107-3 (NS-5) 58 Acres
An artificial reservoir; part of the water supply for the City of Gloucester. Flowage is with the Gloucester Water Department. There is no present recreational use.
- Fernwood Lake #5-5-107-8 to 10 (NS-5) 25 Acres
An artificial reservoir; part of the Gloucester City Water Supply. Flowage is with the water authority. No recreational use is permitted.
- Goose Cove Reservoir #5-5-107-18 to 21 (NS-5) 121.5 Acres
A recently constructed reservoir; part of the Gloucester City Water Supply. Flowage is with the Gloucester Water Department. The reservoir is not presently used for recreation.
- Haskell Pond #5-5-107-2 (NS-5) 50 Acres
An artificial water supply reservoir owned by the City of Gloucester, Gloucester Water Department. The reservoir is presently closed to use by the public.
- Lily Pond #5-5-107-4 (NS-5) 34 Acres
An artificial reservoir; auxiliary water supply for the City of Gloucester. Flowage is with the Gloucester Water Department. There is no present public recreational use.
- Niles Pond (NS-5) 35 Acres
A natural great pond identified by the Division of Waterways (DEQE). No formal access has been provided.
- Wallace Reservoir #5-5-107-6 (NS-5) 25 Acres
An artificial municipal water supply reservoir presently closed to public use. Flowage is with the City of Gloucester Water Department.

7. Lynn

- Birch Pond #5-5-163-6 (NS-7) 80 Acres
An artificial pond; part of the water supply for the City of Lynn. Flowage rights are with the City Water Department. Public fishing is presently allowed.
- Breeds Pond #5-5-163-4 & 5 (NS-7) 179 Acres
An artificial reservoir which serves as part of the water supply for the City of Lynn. Flowage rights are with the Lynn Water Department. Public fishing is presently allowed.
- Flax Pond (NS-6) 46 Acres
A natural great pond identified by the Division of Waterways (DEQE). No formal public access has been provided.
- Floating Bridge Pond (NS-6) 13 Acres
An apparent natural great pond. There is no formal public access.
- Sluice Pond #5-5-163-2 (NS-6) 50 Acres
An apparent enlarged great pond stocked by the Massachusetts Division of Fisheries and Wildlife. Flowage rights are with the City of Lynn, Sewage Division. There is no formal public access. A town-owned boat launching ramp is present.
- Spring Pond #5-5-229-12 (NS-6) 49 Acres
An apparent enlarged great pond which serves as part of the water supply for the City of Peabody. The dam is owned by the city. The pond is presently closed to recreation.
- Walden Pond #5-5-163-1 (NS-7) 223 Acres
An artificial municipal reservoir. Public fishing is presently allowed. Flowage is with the City of Lynn (DPW) and is part of the city's water supply.

8. Lynnfield

- Hawkes Pond #5-5-262-1 (NS-7) 73 Acres
An artificial reservoir used as water supply. The water rights are owned by the City of Lynn, Department of Public Works. It is presently closed to public recreational use.
- Pilling Pond #5-5-164-1 (NS-7) 94 Acres
An apparent enlarged great pond for which no formal public access has been provided.

8. Lynnfield (continued)
Suntaug Lake (IP-04) 154 Acres
An apparent natural great pond used as water supply by the City of Peabody. At present, boating and fishing are allowed for town residents.
Walden Pond #5-5-163-1 (NS-7) 223 Acres
(See Walden Pond - Lynn)
9. Malden
Fellsmere Pond (NS-8) 5.5 Acres
An artificial publicly-owned pond. Informal public access is available since the pond is contained in state land in the Middlesex Fells Reservation, administered by the MDC. The pond is used for recreation.
10. Manchester
No lakes, ponds, or reservoirs that meet criteria.
11. Marblehead
No lakes, ponds, or reservoirs that meet criteria.
12. Melrose
Ell Pond (NS-8) 21 Acres
An apparent natural great pond. No formal public access has been provided. The pond is not presently open to public recreational use.
13. Medford
Middle Reservoir (NS-8) 58 Acres
An artificial municipal reservoir used as water supply by the Town of Winchester. The dam is owned by the town. Fishing is not presently permitted.
South Reservoir (NS-8) 81 Acres
An artificial reservoir which serves as part of the water supply system for the Town of Winchester. Flowage rights are with the town. Fishing is not permitted at present.
13. Medford (continued)
Spot Pond (NS-8) 290 Acres
An apparent enlarged great pond, part of the MDC water supply system. The dam and water rights are owned by the Commission. The pond is presently closed to recreational use.
Lower Mystic Lake (NS-8) 84 Acres
An apparent natural great pond contained in the Middlesex Fells Reservation, administered by MDC. Informal access is available to the public over land in this reservation. The pond is used for recreation.
Upper Mystic Lake #4-9-10-1 (NS-8) 165 Acres
An enlarged apparent great pond. Informal access is available to the public, since the lake is contained in the MDC's Middlesex Fells Reservation. A swimming beach has been developed by the MDC.
Wright's Pond (NS-8) 24 Acres
An artificial municipal pond contained in the City of Medford's Wright Park. Flowage rights are with the city. The pond presently provides recreation for town residents by permit.
14. Nahant
No lakes, ponds, or reservoirs that meet criteria.
15. Peabody
Brown's Pond #5-5-229-11 (NS-6) 26 Acres
An enlarged great pond, identified by the Division of Waterways (DEQE). Flowage rights are with the City of Peabody, Water Department. Swimming and fishing are presently available across town-owned land. There is no formal public access.
Cedar Pond (NS-6) 11 Acres
An apparent natural great pond which serves as emergency water supply for the City of Peabody.
Devils Dishfull Pond #5-5-229-3 (IP-04) 27 Acres
A small artificial municipal pond. The dam is owned by the Peabody Conservation Commission. The pond provides recreation for town residents.

15. Peabody (continued)

Spring Pond #5-5-229-12 (NS-6) 49 Acres

(See Spring Pond, Lynn)

Suntaug Lake (IP-04) 154 Acres

(See Suntaug Lake, Lynnfield)

Winona Pond #5-5-229-14 (IP-04) 92 Acres

An enlarged apparent natural great pond which serves as part of the water supply for the City of Peabody. Flowage is with the City of Peabody Water Department. There is presently fishing by permit for town residents.

16. Revere

No lakes, ponds, or reservoirs that meet criteria.

17. Rockport

Cape Pond (NS-5) 38 Acres

An apparent natural great pond which serves as part of the water supply for the Town of Rockport. It is not presently open to public use.

18. Salem

No lakes, ponds, or reservoirs that meet criteria.

19. Saugus

Birch Pond #5-5-163-6 (NS-7) 80 Acres

(See Birch Pond, Lynn)

Hawkes Pond #5-5-262-1 (NS-7) 73 Acres

(See Hawkes Pond, Lynnfield)

Lower Breakheart Pond #5-5-262-10 (NS-7) 19 Acres

An artificial publicly-owned pond used for recreation. Informal public access to these public waters is available across the Breakheart Reservation, administered by the MDC. A swimming area has been developed. The pond is also known as Pearce Lake.

19. Saugus (continued)

Upper Breakheart Pond (Long John Silver Lake)
#5-5-262-9 (NS-7) 13 Acres

An artificial pond is contained in the Breakheart Reservation of the MDC. There is informal public access to the public waters. The pond is used for recreation.

Walden Pond #5-5-262-3 (NS-7) 223 Acres

(See Lynn)

20. Salem

No lakes, ponds, or reservoirs that meet criteria.

21. Stoneham

Boogum Rock Pond (NS-8) 6 Acres

A small natural pond in the Middlesex Fells Reservation of the MDC. Informal public access is available to the public waters. The pond is used for recreation.

Crystal Lake (NS-8) 80 Acres

An apparent natural great pond. No formal public access has been provided.

Dark Hollow Pond (NS-8) 6 Acres

A small, natural public pond which is presently stocked for fishing. Informal access is available for the public, since the pond is contained in the Middlesex Fells Reservation, administered by the MDC.

Doleful Pond (NS-8) 7 Acres

A small natural pond contained in the Middlesex Fells Reservation of the MDC. Informal public access is available through the Reservation. The pond is used for recreation.

Fells Reservoir (NS-8) 8.5 Acres

A small artificial reservoir in the MDC's Middlesex Fells Reservation used as water supply. The dam is owned by the MDC, and the pond is closed to recreational use.

Middle Reservoir (NS-8) 58 Acres

(See Middle Reservoir, Medford)

21. Stoneham (continued)

North Reservoir (NS-8) 59 Acres

An artificial municipal reservoir used as water supply by the Town of Winchester. Flowage is with the Town of Winchester. Fishing is not presently permitted.

South Reservoir (NS-8) 81 Acres

(See South Reservoir, Medford)

Spot Pond (NS-8) 290 Acres

(See Spot Pond, Medford)

22. Swampscott

No lakes, ponds, or reservoirs that meet criteria.

23. Wakefield

Crystal Lake (NS-8) 80 Acres

(See Stoneham)

Lake Quannipowitt #4-9-305-1 (NS-8) 254 Acres

An enlarged natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided. At present, the town provides public access across town park land to a boat ramp. Flowage rights are owned by the Town of Wakefield.

24. Winchester

Upper Mystic Lake (NS-8) 165 Acres

(See Medford)

Wedge Pond #4-9-344-2 (NS-8) 22 Acres

An enlarged great pond. Formal access for the public has not been provided. Flowage is with the Town of Winchester. The pond has been surveyed by the Division of Waterways (DEQE).

Winter Pond (NS-8) 17 Acres

An apparent natural great pond for which no formal public access has been provided.

24. Winchester (continued)

North Reservoir #4-9-344-1 (NS-8) 55 Acres

(See North Reservoir, Stoneham)

25. Winthrop

No lakes, ponds, or reservoirs that meet criteria.

26. Woburn

Horn Pond (NS-8) 104 Acres

An enlarged apparent great pond. Public access has been provided by the Massachusetts Public Access Board. Flowage is with the City of Woburn.

NEPONSET STUDY AREA COMMUNITIES

1. Boston

Chestnut Hill Reservoir (CH-15) 85 Acres

An artificial reservoir which is part of the MDC's water supply system. Water rights are with the MDC. Although the waters of the reservoir are closed to recreation, the adjacent lands are used extensively.

Jamaica Pond (CH-15) 62 Acres

A natural great pond, surveyed by the Division of Waterways (DEQE). Stocked for fishing by the Division of Fisheries and Wildlife. Fishing is by permit from The Boston Parks and Recreation Department, which administers the adjoining Frederick Law Olmsted Park. Informal access can be gained across this parkland. A boat livery is available.

Sprague Pond (NE-22) 13 Acres

A natural great pond. No formal access has been provided.

2. Canton

Bolivar Pond #6-11-50-4 (NE-19) 29 Acres

An artificial municipally-owned pond. There is no formal public access, and the pond provides fishing for local residents.

2. Canton (continued)

Glen Echo Pond (NE-19) 16 Acres
A natural great pond, identified by the Division of Waterways (DEQE). No formal public access has been provided.
Ponkapoag Pond (NE-20) 209 Acres

An apparent great pond. Informal public access is available through the MDC's Blue Hills Reservation. The pond is used for recreation.

3. Milton

Hillside Pond (NE-21) 3 Acres
An enlarged natural pond in the Blue Hills Reservation of the MDC. Access can be gained across MDC land.

Pine Tree Brook Reservoir #8-11-189-5 (NE-21) 94 Acres
An artificial reservoir was constructed under the Watershed Protection and Flood Prevention Act, (PL-566). The project was a cooperative effort of federal, state and local interest. The reservoir provides flood control and recreational benefits. Informal public access has been provided, and flowage rights are with the Town of Milton.

Hoosic/whisick Pond (Houghton's Pond) (SS-24) 25 Acres

An apparent natural great pond. Informal access to the waters can be gained across MDC's Blue Hills Reservation. The pond is used for recreation. It is presently stocked with fish by the Division of Fisheries and Wildlife. A beach has been developed.

4. Norwood

Ellis Pond (NE-20) 22 Acres
An artificial municipal pond. The pond provides some recreation for local residents.

5. Sharon

East Pond (TA-55) 2 Acres
An artificial public pond. Informal access can be gained across state land in the Borderland State Park, administered by the DEM. Water rights are with the Commonwealth. The pond is used for recreation. Fishing is presently permitted from nonpower boats.

5. Sharon (continued)

Massapoag Lake #6-11-266-1 (NE-19) 353 Acres
An enlarged natural great pond identified by the Division of Waterways (DEQE). Flowage rights are with the Town of Sharon. Informal access is available for the public to a town-owned swimming beach. The lake is used for recreation.

Middle Pond (TA-54) 6 Acres
A small artificial pond within the Borderland State Park. Informal public access is available across the parkland administered by DEM. Flowage is with the state. The pond is used for recreation.

Pud's Pond (TA-54) 20 Acres
An artificial pond within DEM's Borderland State Park. Flowage rights to the public waters are with the state. Access can be gained through the Park. The pond is used for recreation.

Upper Leach Pond (TA-54) 25 Acres
An artificial public pond within DEM's Borderland State Park. Informal access to these public waters can be gained across this state-owned land. Water rights are with the state. The pond is used for recreation. Fishing is presently permitted from nonpower boats.

West Pond (TA-54) 5 Acres
A small public pond enclosed in Borderland State Park. The water rights are with the state. Informal access is available for the public across this state land. The pond is used for recreation.

Wolomolopoag Pond (TA-55) 11 Acres
A natural great pond identified by the Division of Waterways (DEQE). There is no formal public access.

6. Walpole

Cobbs Pond #6-11-307-15 (NE-17) 26 Acres
An artificial municipally-owned pond that furnishes local recreation. The dam is owned by the Town of Walpole.

4. Bridgewater
Carver Pond #7-12-42-7 (TA-51) 31 Acres
A municipally-owned artificial pond. Access is limited to local residents. The dam and flowage rights are controlled by the Town of Bridgewater. The pond is used for recreation.
Lake Nippenicket (TA-47) 354 Acres
A natural great pond designated by the Division of Waterways (DEQE). Access developed for fishing and swimming by the Public Access Board. Surrounding land in the Hockamock Swamp Management Area is used as a wildlife management area by the Division of Fisheries and Wildlife.
Nunkets Pond (Nuggerty) (TA-47) 16 Acres
An apparent natural great pond. Informal access available across Fish and Wildlife land in the Hockamock Wildlife Management Area.
5. Brockton
Thirty-Acre Pond #7-12-44-6 (TA-48) 24 Acres
A municipally-owned artificial pond located in D. W. Field Park. Informal access for recreation is available across the park land. The City of Brockton controls the dam and flowage rights.
6. Dighton
No lakes, ponds, or reservoirs which meet criteria.
7. East Bridgewater
Robbins Pond #7-12-118-1 (TA-49) 124 Acres
An enlarged great pond surveyed by the Division of Waterways (DEQE), with access established by the Public Access Board for recreation. The dam is owned by the Town of Halifax, while the flowage rights are controlled by the United Cape Cod Cranberry Corporation.
8. Easton
Ames Long Pond (Long Pond) #6-3-88-1 (TA-47) 75 Acres
A municipally-owned artificial pond used for recreation. A town beach has been developed by the Town of Stoughton. The dam and flowage rights are controlled by the Town of Easton. There is no public access.

7. Westwood
Buckmaster Pond (NE-20) 29 Acres
An enlarged great pond identified by the Division of Waterways (DEQE). Withdrawn for water supply by the Town of Norwood. At present, access for fishing from nonpower boats has been granted to Norwood and Westwood residents by the water authority.
Lyman Pond (NE-20) 26 Acres
An artificial municipally-owned pond. Water rights are with the Town of Westwood. The pond is used for recreation. There is no formal public access.
- SOUTHEAST SUBAREA
TAUNTON STUDY AREA COMMUNITIES
1. Abington
Cleveland Pond #7-12-1-2* (TA-48)+ 100 Acres
A publicly-owned artificial pond located in Ames Nowell State Park with informal public access available across the state land. The dam and flowage rights are controlled by the DEM, the agency that administers the Park. The pond is used for recreation.
Island Grove Pond #7-12-1-1 (TA-49) 35 Acres
A municipally-owned artificial pond. Access is limited to town residents. The Town of Abington owns the dam and flowage rights.
 2. Avon
Brockton Reservoir #6-11-18-1 (TA-48) 85 Acres
An artificial pond located in the City of Brockton's D. W. Field Park, used as water supply by the City of Brockton. The city also owns the dam and flowage rights. At present, passive recreation is available.
Waldo Lake #7-12-44-9 (TA-48) 75 Acres
A municipally-owned artificial pond located within D. W. Field Park with informal access for recreation provided. The dam and flowage rights are controlled by the City of Brockton.
 3. Berkley
No lakes, ponds, or reservoirs which meet criteria.

8. Easton (continued)
Leach Pond (Wilber) (TA-54) 110 Acres
A publicly-owned artificial pond within Borderland State Park. Fishing from nonpower boats is permitted at present. Informal access for other types of recreation is available across state park land. The DEM controls the dam and flowage rights.
9. Foxborough
Carpenter Pond (Lakeview Pond) #6-11-99-7 (TA-55) 30 Acres
A municipally-owned artificial pond. The dam and flowage rights are with the Foxborough Conservation Commission. No formal public access has been provided.
Upper Dam Pond #6-11-99-8 (TA-55) 21 Acres
A municipally-owned artificial pond. The dam and flowage rights are controlled by the Foxborough Conservation Commission. No formal public access has been provided.
Witch Pond (NB-60) 10 Acres
An apparent natural great pond. There is no formal public access.
10. Freetown
Long Pond (TA-53) 1,721 Acres
(See Lakeville)
11. Halifax
Monponsett Pond (TA-49) 528 Acres
A natural great pond identified by the Division of Waterways (DEQE). The Wamsutta Beach site has been purchased as formal, public access by the Public Access Board. At the present time, swimming is the only developed recreation.
Muddy Pond (TA-49) 15 Acres
An apparent natural great pond for which no public access has been provided.
12. Hanson
Indian Head Pond (SS-27) 121 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access.
12. Hanson (continued)
Maquan Pond (SS-27) 45 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access.
Wampatuck Pond #7-12-123-1 (SS-27) 65 Acres
A municipally-owned artificial pond. Access limited to local residents. The Town of Hanson controls the dam and flowage rights.
13. Lakeville
Assawompset Pond (TA-53) 2,024 Acres
An enlarged great pond withdrawn for water supply by the Cities of Taunton and New Bedford. The dam and flowage rights are owned by the City of Taunton. There is no public access or recreational use at present.
Clear Pond (TA-52) 18 Acres
An apparent natural great pond with no public access.
Elders Pond (TA-53) 145 Acres
An apparent natural great pond used as water supply by the City of Taunton. No public access is available.
Long Pond (TA-53) 1,721 Acres
A natural great pond identified by the Division of Waterways (DEQE). Access for recreation established by the Massachusetts Public Access Board at a site located in Freetown. It is used for water supply by the City of New Bedford.
Loon Pond (TA-53) 23 Acres
A natural great pond identified by the Division of Waterways (DEQE). No formal public access.
Great Quittacas Pond (TA-53) 1,185 Acres
An apparent natural great pond used as water supply by the City of New Bedford. Recreation here is limited to boating and fishing by permit for owners abutting the pond only. There is no public access.
Little Quittacas Pond (TA-53) 297 Acres
An apparent natural great pond used as water supply by the City of New Bedford. Access is limited to boating and fishing by permit for owners abutting the pond.

14. Mansfield

Greenwood Lake (Bungay Lake) #6-3-211-7 (NB-60) 130 Acres
A federally-owned artificial lake. There is no formal public access. The U.S. Department of The Interior owns the dam and flowage rights.

15. Middleborough

Pocksha Pond (TA-53) 230 Acres
An apparent natural great pond with no formal public access provided.

Tispaquin Pond (TA-53) 194 Acres
An apparent natural great pond with formal public access. Acquired by the Public Access Board, but not fully developed at the present time.

Woods Pond #7-12-182-2 (TA-53) 50 Acres
An apparent enlarged great pond with no formal public access. It is used as water storage for cranberry bogs. The dam and flowage rights are controlled by John Howes. A license from the Division of Waterways (DEQE) exists on the pond.

16. Norton

Winneconnet Pond (TA-54) 146 Acres
An apparent natural great pond with no formal public access.

17. Plympton

Indian Pond (SS-29) 66 Acres
(See Kingston)

18. Raynham

Gushee Pond (TA-52) 30 Acres
An apparent natural great pond with no public access.
Lake Nippenicket (TA-47) 354 Acres
(See Bridgewater)

19. Stoughton

Ames Long Pond #6-3-88-1 (TA-47) 75 Acres
(See Easton)
Pinewood Pond #6-11-285-2 (NE-19) 21 Acres
A municipally-owned artificial pond used as a secondary water supply. The Town of Stoughton controls the dam and flowage rights. No public access has been provided.

Welch Pond (TA-47) 40 Acres

A municipally-owned artificial pond used for water retention and recreation for local residents. The Stoughton Conservation Commission owns the dam and flowage rights. There is no public access.

Woods Pond (NE-19) 25 Acres

An artificial pond used for water storage with no public recreational use at present. The Town of Stoughton owns the dam and flowage rights.

20. Taunton

Big Bearhole Pond (Deans Factory Pond) #6-3-293 15 (TA-52) 40 Acres

An artificial pond located in the Massasoit State Park. Informal public access for recreation is available across this state land. The DEM controls the dam and flowage rights.

Little Bearhole Pond (TA-52) 5 Acres

An artificial pond located in the Massasoit State Park with public access for recreation. The dam and flowage rights along with the administration of the park are with the DEM.

Black Pond (TA-54) 11 Acres

A great pond surveyed by the Division of Waterways (DEQE). No formal public access.

Middle Pond #6-3-293-16 (TA-52) 20 Acres

An artificial pond located within Massasoit State Park. Informal public access for recreation is available across this state land. The DEM controls the dam and flowage rights and administers the state park.

20. Taunton (continued) 42 Acres
- Prospect Hill Pond (TA-52)
- An apparent natural great pond with no formal public access.
- Sabbattia Lake (Seading Pond) #6-3-293-4 (TA-54) 255 Acres
- An enlarged great pond surveyed by the Division of Waterways (DEQE). Public access for boating has been developed by the Massachusetts Public Access Board. The dam and flowage rights are controlled by Dye Craftsman, Inc. of Taunton.
- Watson Pond (TA-54) 70 Acres
- An apparent enlarged great pond contiguous to the Watson Pond State Park. Informal public access for recreation can be obtained across the park. The DEM controls the dam and flowage rights, and administers the state park.
21. West Bridgewater
- Town River Pond #7-12-322-3 (TA-47) 30 Acres
- A municipally-owned artificial pond. At present, access is available to town residents for recreation. The Town of West Bridgewater owns the dam and flowage rights.
- West Meadow Pond #7-12-322-3 (TA-47) 20 Acres
- A publicly-owned artificial pond within the West Meadows Wildlife Management Area. The Division of Fisheries and Wildlife owns the dam and flowage rights. Presently, it is not being used for recreation.
- BUZZARDS BAY STUDY AREA COMMUNITIES
1. Acushnet 220 Acres
- New Bedford Reservoir #6-3-3-3 (BB-45)
- A municipal artificial reservoir used for irrigation and recreation for town residents. The dam and flowage rights are controlled by the Town of Acushnet.
2. Carver 14 Acres
- Barrett Pond (BB-41)
- An apparent natural great pond for which there is informal access for recreation through Myles Standish State Forest, under the jurisdiction of the DEM.

2. Carver (continued)
- Bates Pond (BB-42) 20 Acres
- An apparent natural great pond. No formal public access has been provided.
- Cedar Pond (BB-43) 12 Acres
- An apparent natural great pond for which there is no formal public access.
- Clear Pond (BB-43) 11 Acres
- An apparent natural great pond. There is no formal public access to the waters.
- Coopers Pond (TA-50) 23 Acres
- A natural great pond identified by the Division of Waterways (DEQE). No formal access has been provided.
- Dunham Pond (BB-43) 45 Acres
- A great pond identified by the Division of Waterways (DEQE). Formal public access has been provided by the same agency.
- Fresh Meadow Pond #7-12-52-9 (BB-42) 60 Acres
- An apparent enlarged great pond used as water storage for cranberry bogs. The A. D. Makepeace Company controls the dam and flowage rights.
- John's Pond (TA-50) 21 Acres
- An apparent natural great pond. There is no formal public access.
- Ricketts Pond (TA-50) 11 Acres
- An apparent natural great pond. There is no formal public access.
- Sampson Pond (BB-43) 310 Acres
- A great pond designated by the Division of Waterways (DEQE). No formal public access.
- Vaughn Pond #7-12-52-52 (BB-42) 22 Acres
- An enlarged great pond surveyed by the Division of Waterways (DEQE). It is used for the irrigation of cranberry bogs. The dam and flowage rights are owned by Louis Poduck. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from this pond. No public access has been provided.

2. Carver (continued)

Wenham Pond (BB-42) 50 Acres

An enlarged great pond surveyed by the Division of Waterways (DEQE) and used for cranberry bog irrigation. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from this pond. No public access has been provided.

3. Dartmouth

Cedar Dell Lake (BB-45) 24 Acres

An apparent natural great pond. No formal public access.

Georges Pond (BB-45) 16 Acres

An apparent natural great pond located within the Demarest Lloyd State Park, under the jurisdiction of the DEM. Informal access for fishing, boating, and swimming is available across state park land.

Noquochoke Lake #6-3-72-1 (BB-46) 165 Acres

An artificial pond used as secondary water supply by the City of Fall River. Access is available for local residents presently.

West Noquochoke Pond (BB-46) 20 Acres

An artificial pond used as a secondary water supply by the City of Fall River. Access is presently available only for town residents.

Salters Point Pond (BB-45) 58 Acres

An apparent natural great pond. There is no formal public access.

4. Fairhaven

Sconticut Neck Pond (BB-45) 13 Acres

An apparent natural great pond with no formal public access.

5. Fall River

Cook Pond (Laurel Lake) #6-3-95-14 (NB-71) 154 Acres

An apparent enlarged great pond with public access for fishing. A boat ramp has been developed by the Massachusetts Division of Fisheries and Wildlife. The dam and flowage rights are with the City of Fall River.

5. Fall River (continued)

Copicut Reservoir #6-3-95-16 (BB-46) 550 Acres

An artificial municipal water supply reservoir for the City of Fall River. Water rights are with the Watuppa Water Board. The reservoir is currently closed to public use.

North Watuppa Lake (North Watuppa Reservoir)
#6-3-95-13 (NB-71) 1,750 Acres

An enlarged great pond identified by the Division of Waterways (DEQE) and is used as a municipal water supply by the City of Fall River. Water rights are with the City of Fall River, with access being restricted.

South Watuppa Pond #6-3-95-3, 4 (NB-71) 1,660 Acres

An apparent enlarged great pond used for an industrial water supply. Formal access for boating has been developed by the Massachusetts Public Access Board. The dam and flowage rights are with the City of Fall River.

Sawdy Pond #6-3-334-2 (NB-71) 370 Acres
(See Westport)

6. New Bedford

Sassaquin Pond (TA-53) 34 Acres

A natural great pond designated by the Division of Waterways (DEQE). No formal public access available.

7. Rochester

Long Pond (Black Pond) (BB-44) 33 Acres

An apparent natural great pond with no public access.

Mary's Pond (BE-44) 81 Acres

An apparent natural great pond with no formal public access.

Snipatuit Pond (BB-44) 710 Acres

An enlarged great pond identified by the Division of Waterways (DEQE). Informal public access is available across state land administered by the Massachusetts Division of Fisheries and Wildlife. The dam and flowage rights are also with the state.

5. Fall River (continued)
Snows Pond (BB-44) 58 Acres
An apparent natural great pond with no formal public access.
Rochester Rearing Reservoir (BB-44) 4 Acres
An artificial pond owned by the Massachusetts Division of Fisheries and Wildlife. Fishing is permitted off Snipatuit Road. The dam and flowage rights are controlled by the Massachusetts Division of Fisheries and Wildlife.
8. Wareham
Blackmore Pond (BB-42) 46 Acres
A great pond surveyed by the Division of Waterways (DEQE). No formal public access.
Cedar Pond (BB-41) 12 Acres
An apparent natural great pond. No formal public access.
Dicks Pond (BB-41) 40 Acres
An apparent enlarged great pond. The waters are used for cranberry bog irrigation by Daniel O'Connor. No public access has been provided.
Little Long Pond (BB-41) 18 Acres
An apparent natural great pond. Public access has not been obtained.
Sand Pond (Jonathan's Pond) (BB-41) 15 Acres
An apparent natural great pond with no public access. It is used for water supply by the Town of Wareham.
Sandy Pond (Pickerel Pond) (BB-41) 18 Acres
An apparent natural great pond which has been withdrawn for water supply by the Town of Wareham. No access for recreational use is presently permitted.
Spectacle Pond (BB-41) 42 Acres
An apparent natural great pond with no formal public access.
Tremont Mill Pond #7-12-310-8 (BB-42) 33 Acres
A municipally-owned artificial pond currently used for cranberry bog irrigation and recreation for town residents. The dam and flowage rights are controlled by the Town of Wareham.
8. Wareham (continued)
Union Pond (BB-41) 25 Acres
An apparent natural great pond with no formal public access.
White Island Pond #7-12-310-18 (BB-41) 294 Acres
An apparent enlarged great pond used for the irrigation of cranberry bogs and recreation for local residents. The A. D. Makepeace Company controls the dam and flowage rights. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from the pond.
9. Westport
Cockeast Pond (BB-46) 99 Acres
An apparent natural great pond with no formal public access.
Devol Pond (NB-71) 108 Acres
An apparent natural great pond which has been withdrawn for water supply by the City of Fall River. The water rights are owned by the city. Access is limited to local residents. Fishing is allowed.
North Watuppa Lake #6-3-95-13 (NB-71) 1,750 Acres
(See Fall River)
Richmond Pond (BB-46) 67 Acres
An apparent natural great pond with no formal public access.
Sawdy Pond #6-3-334-2 (NB-71) 363 Acres
An apparent enlarged great pond which has been withdrawn for water supply by the City of Fall River. Water rights are with the city. At present, access is available to local residents for recreation.
South Watuppa Pond #6-3-95-3, 4 (NB-71) 1,660 Acres
(See Fall River)
1. Attleboro
Luther Reservoir #6-3-16-9 (NB-60) 25 Acres
A municipally-owned artificial pond used for water supply by the City of Attleboro. The dam and flowage rights are controlled by Attleboro. Fishing is permitted for town residents.

NARRAGANSETT BAY STUDY AREA

6. Swansea

No lakes, ponds, or reservoirs meet criteria.

CAPE COD AND ISLANDS REGION
PUBLIC LAKES, PONDS AND RESERVOIRS
CAPE COD STUDY AREA COMMUNITIES

1. Barnstable

Aunt Betty Pond (CC-38)+ 10 Acres

An apparent natural great pond for which no public access has been provided.

Bearse Pond (CC-39) 65 Acres

An apparent natural great pond with informal access through state land under the jurisdiction of the Department of Fisheries and Wildlife.

Crystal Lake (CC-39) 10 Acres

An apparent natural great pond. No formal public access has been provided.

Eagle Pond (CC-39) 10.5 Acres

An apparent natural great pond with no formal public access provided.

Elizabeth Pond (CC-39) 13 Acres

An apparent natural great pond with no formal public access available.

Garretts Pond (CC-32) 24 Acres

An apparent natural great pond with no formal public access.

Hamblins Pond (CC-39) 149 Acres

A natural great pond identified by the Division of Waterways (DEQE). The pond is presently stocked by the Massachusetts Division of Fisheries and Wildlife. There is no formal public access. A license from the Division of Waterways exists to withdraw water from the pond.

Hathaway Pond North (CC-39) 20 Acres

An apparent natural great pond stocked by the Massachusetts Division of Fisheries and Wildlife. No formal public access has been provided.

1. Attleboro (continued)

Manchester Reservoir #6-3-16-12 (NB-60) 225 Acres

An artificial municipal water supply reservoir. Water rights are with the City of Attleboro. Fishing is available for town residents

Orrs Pond (Upper Orrs Reservoir) #6-3-16-5 (NB-60) 50 Acres

An artificial reservoir which serves as part of the water supply for the City of Attleboro. The dam and flowage rights are controlled by Attleboro. For town residents, fishing is allowed.

2. North Attleborough

Coral Lake (Falls Pond North) #6-3-211-12 (NB-60) 60 Acres

A municipally-owned artificial pond with recreational access for boating established by the Public Access Board. The North Attleborough Conservation Commission controls the dam and flowage rights.

Hoppin Hill Reservoir #6-3-211-5 (NB-60) 35 Acres

An artificial reservoir used for water supply by the City of Attleboro. The city controls the dam and flowage rights. Fishing is allowed for town residents.

Reservoir Pond (NB-60) 45 Acres

An enlarged great pond. Access for recreation is limited to town residents. The North Attleborough Conservation Commission controls the dam and flowage rights.

3. Plainville

Lake Mirimichi (Shepards) #6-11-283-7 (TA-55) 170 Acres

An enlarged great pond with no formal public access. The dam and flowage rights are controlled by the City of Attleboro for use as a secondary water supply.

4. Rehoboth

No lakes, ponds, or reservoirs meet criteria.

5. Somerset

Somerset Reservoir #6-3-273-1 (NB-72) 165 Acres

A municipally-owned artificial water supply reservoir. The dam and flowage rights are controlled by the Town of Somerset. The reservoir is currently closed to public use.

1. Barnstable (continued)

Hathaway Pond South (CC-39) 11 Acres
An apparent natural great pond. No formal public access has been provided.

Hinckley Pond (CC-32) 11 Acres
An apparent natural great pond. No formal public access has been provided.

Joshua Pond (CC-39) 14 Acres
An apparent natural great pond with no formal public access.

Lamson Pond (CC-38) 14 Acres
An apparent natural great pond with no formal public access.

Little Pond (CC-39) 11 Acres
An apparent natural great pond. No formal public access has been provided. A license from the Division of Waterways (DEQE) exists to withdraw water from the pond.

Long Pond (CC-39) 50 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). There is no formal public access. The pond is located near Centerville.

Long Pond (CC-39) 50 Acres
A natural great pond designated by the Division of Waterways (DEQE), with no formal public access. It is located in the Newtown section of Barnstable.

Lovells Pond (CC-39) 54 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). Formal public access for recreation has been obtained through the Public Access Board. A boat landing has been constructed. The pond is stocked by the Massachusetts Division of Fisheries and Wildlife.

Mary Dunn's Pond (Half-Way) (CC-38) 16 Acres
An apparent natural great pond that has been withdrawn for water supply by the Town of Barnstable. It is not presently used for recreation.

1. Barnstable (continued)

Micah Pond (CC-39) 14 Acres
An apparent natural great pond with no formal public access.

Middle Pond (Middle Cotuit) #7-1-20-9 (CC-39) 104 Acres
An enlarged great pond surveyed by the Division of Waterways (DEQE). No public access has been provided. The dam and flowage rights are owned by A. D. Makepeace Company. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from the pond.

Mill Pond (CC-32) 21 Acres
An apparent natural great pond located in West Barnstable with no formal public access.

Muddy Pond (CC-39) 27 Acres
An apparent natural great pond. No formal public access has been provided.

Mystic Lake (CC-39) 146 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from the pond.

Neck Pond (CC-39) 15 Acres
An apparent natural great pond. There is no formal public access.

Parker Pond (CC-39) 13 Acres
An apparent natural great pond with no public access.

Shallow Pond (CC-39) 67 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access.

Shubael Pond (CC-39) 56 Acres
A great pond surveyed by the Division of Waterways (DEQE). Public access for recreation has been acquired by the Public Access Board. A landing for small boats has been constructed. The pond is stocked by the Massachusetts Division of Fisheries and Wildlife.

1. Barnstable (continued)
Wequaquet Lake (Chequaquet) #7-1-20-8 (CC-39) 654 Acres
An enlarged great pond surveyed by the Division of Waterways (DEQE). There is no formal public access. The dam and flowage rights are with the Town of Barnstable. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from the pond.
2. Bourne
Bourne Pond (BB-41) 10 Acres
An apparent natural great pond with no formal public access.
Flax Pond (Picture Lake) (CC-40) 27 Acres
An apparent natural great pond with no public access.
Goat Pond (Goat Pasture Pond) (BB-41) 24 Acres
An apparent natural great pond with no formal public access.
Great Herring Pond (SS-31) 410 Acres
(See Plymouth)
3. Brewster
Queen Sewell Pond (Bumps Pond) (BB-41) 18 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). There is no public access. A license from the Division of Waterways (DEQE) exists to withdraw water from the pond.
3. Brewster (continued)
Cliff Pond (CC-33) 193 Acres
A great pond identified by the Division of Waterways (DEQE). Informal public access to the public waters can be gained across the Nickerson State Park administered by the DEM. The pond is stocked by the Massachusetts Division of Fisheries and Wildlife. Access for boating has been developed by the Public Access Board.
Little Cliff Pond (CC-33) 33 Acres
A natural great pond identified by the Division of Waterways (DEQE) and located within the Nickerson State Park. Access for boating has been developed by the Massachusetts Public Access Board. The pond is presently stocked by the Massachusetts Division of Fisheries and Wildlife.
Cobbs Pond (CC-33) 21 Acres
An apparent natural great pond with no public access.
Elbow Pond (CC-33) 31 Acres
An apparent great pond with no formal public access.
Eel Pond (CC-33) 3 Acres
A publicly-owned natural pond located in Nickerson State Park provides passive recreation. Informal access can be gained across the park land administered by DEM.
Flax Pond (CC-33) 48 Acres
A great pond identified by the Division of Waterways (DEQE). The public waters are within the DEM's Nickerson State Park. Informal access can be obtained across the state land. A swimming area has been developed by the Massachusetts Division of Forests and Parks, and the pond is presently stocked with fish by the Massachusetts Division of Fisheries and Wildlife.
Grassy Nook Pond (CC-33) 8 Acres
A small natural pond located within Nickerson State Park. Informal access for passive recreation can be gained across state land.
Griffith's Pond (Snow's, White's) (CC-33) 30 Acres
A natural great pond designated by the Division of Waterways (DEQE). No formal public access is available.

3. Brewster (continued)

- Higgins Pond (CC-33) 25 Acres
A natural great pond surveyed by the Division of Waterways (DEQE) and located within the Nickerson State Park, administered by DEM's Division of Forests and Parks. A boating access ramp has been developed. The pond is presently stocked with fish by the Massachusetts Division of Fisheries and Wildlife.
- Greenland Pond (Eldridge) (CC-38) 37 Acres
An apparent natural great pond with no public access.
- Keeler Pond (CC-33) 4 Acres
A small natural pond located within Nickerson State Park. There is informal access for passive recreation available through State Park land.
- Long Pond (CC-38) 743 Acres
A natural great pond designated by the Division of Waterways (DEQE). There is no formal public access.
- Lower Mill Pond #7-1-41-1 (CC-33) 40 Acres
An enlarged great pond surveyed by the Division of Waterways (DEQE). No formal public access has been obtained to the public waters. The dam and flowage rights are owned by the Town of Brewster. It is used for recreation by local residents. A license from the Division of Waterways (DEQE) exists to withdraw water from the pond.
- Upper Mill Pond (Mill Pond, Middle, Walker) (CC-33) 253 Acres
A natural great pond surveyed by the Division of Waterways (DEQE) with no formal public access.
- Pine Pond (CC-33) 20 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided.
- Ruth Pond (CC-33) 8 Acres
A publicly-owned pond located in Nickerson State Park. A public access ramp constructed by the Civilian Conservation Corps (CCC) makes fishing and boating available.

3. Brewster (continued)

- Seymour Pond (Bangs Pond) (CC-38) 168 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided.
- Sheep Pond (CC-38) 142 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). Boating access has been provided by the Public Access Board. The pond is presently stocked by the Massachusetts Division of Fisheries and Wildlife.
- Slough Pond (Walkers Pond) (CC-33) 27 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided.
- Smalls Pond (CC-38) 19 Acres
An apparent natural great pond with no public access.
- Smith Pond (CC-33) 10 Acres
An apparent natural great pond. No formal public access has been provided.
- Walkers Pond (Upper Mill) (CC-33) 105 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). Formal public access has also been provided by the Division of Waterways (DEQE) under Section 18A.
- Chatham
- Emery Pond (CC-37) 13 Acres
An apparent natural great pond. No formal public access has been provided.
- Goose Pond (CC-37) 38 Acres
A natural great pond designated by the Division of Waterways (DEQE). There is no formal public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.
- Lover's Lake (CC-37) 36 Acres
An apparent natural great pond with no formal public access.

4.

4. Chatham (continued)
Mill Pond (CC-37) 22 Acres
An apparent natural great pond. No formal public access has been provided.
Monomoy Pt. Big Pond (CC-37) 26 Acres
An apparent natural great pond with no public access presently provided.
Schoolhouse Pond (CC-37) 21 Acres
A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.
Stillwater Pond (CC-37) 16 Acres
An apparent natural great pond with no public access.
White Pond (CC-37) 40 Acres
A natural great pond surveyed by the Division of Waterways (DEQE), with no formal public access.
5. Dennis
Flax Pond (CC-38) 16 Acres
An apparent natural great pond for which no public access has been provided.
Fresh Pond (CC-38) 29 Acres
An apparent natural great pond. No public access has been provided.
Grassy Pond (CC-38) 12 Acres
An apparent natural great pond with no public access.
Kelley Pond (CC-38) 31 Acres
An apparent natural great pond with no formal public access.
Scargo Lake (CC-33) 53 Acres
A natural great pond designated by the Division of Waterways (DEQE) with no formal public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.
5. Dennis (continued)
Simmons Pond (CC-38) 10 Acres
An apparent natural great pond with no public access.
White Pond (CC-38) 12 Acres
An apparent natural great pond with no public access.
6. Eastham
Depot Pond (CC-34) 25 Acres
An apparent natural great pond with no public access.
Great Pond #7-1-86-1 (CC-34) 109 Acres
An apparent enlarged great pond with no formal public access. The dam and flowage rights are owned by the Town of Eastham.
Minister Pond (Meetinghouse Pond) (CC-34) 21 Acres
An apparent natural great pond with no formal access.
Little Muddy Pond (CC-34) 11 Acres
An apparent natural great pond with no formal public access.
Herring Pond (CC-34) 43 Acres
An apparent natural great pond for which no public access has been provided. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.
7. Falmouth
Cedar Pond (Flax, Cedar Lake) (CC-40) 21 Acres
An apparent natural great pond with no formal public access at present.
Coonamessett Pond (CC-40) 157 Acres
A natural great pond identified by the Division of Waterways (DEQE). There has been no formal public access provided.
Crooked Pond (CC-40) 34 Acres
A great pond surveyed by the Division of Waterways (DEQE) with no formal public access.

7. Falmouth (continued)

Deep Pond (CC-40) 27 Acres
A natural great pond surveyed by the Division of Waterways (DEQE), with no formal public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.

Flax Pond (Factory) (CC-40) 21 Acres
An apparent enlarged great pond with no public access. The dam is owned by the Town of Falmouth as water storage for cranberry irrigation. A license from the Division of Waterways (DEQE) exists to withdraw water from the pond.

Flume Pond (CC-40) 11 Acres
An apparent natural great pond with no formal public access.

Fresh Pond (CC-40) 14 Acres
An apparent natural great pond. No formal public access has been obtained.

Grews Pond (CC-40) 13 Acres
An apparent natural great pond with no public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.

Jenkins Pond (CC-40) 87 Acres
A great pond surveyed by the Division of Waterways (DEQE). There is no formal public access to these public waters.

Jones Pond (CC-40) 12 Acres
An apparent natural great pond. No formal public access has been provided.

Long Pond (CC-40) 150 Acres
A natural great pond identified by the Division of Waterways (DEQE). There is no public access to these public waters. It is used for water supply by the Town of Falmouth.

Mares Pond (CC-40) 28 Acres
A natural great pond designated by the Division of Waterways (DEQE). At present, there is no formal public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.

7. Falmouth (continued)

Morse Pond (CC-40) 15 Acres
An apparent natural great pond with no public access. A license from the Division of Waterways (DEQE) exists to withdraw water from the pond.

Oyster Pond (CC-40) 61 Acres
An apparent natural great pond with no formal public access.

Round Pond (CC-40) 19 Acres
A natural great pond surveyed by the Division of Waterways (DEQE) with no formal public access. It is located near Jenkins Pond.

Round Pond (CC-40) 11 Acres
An apparent natural great pond which has no public access. It is located near Coonasset Pond.

Shallow Pond (CC-40) 11 Acres
A natural great pond identified by the Division of Waterways (DEQE) with no formal public access.

Siders Pond (Fresh) (CC-40) 34 Acres
A natural great pond identified by the Division of Waterways (DEQE) with no formal public access.

Spectacle Pond (CC-40) 19 Acres
A natural great pond surveyed by the Division of Waterways (DEQE) with no formal public access.

Wings Pond (Herring) (CC-40) 21 Acres
An apparent natural great pond with no present formal public access.

8. Harwich
Aunt Edies Pond (CC-38) 19 Acres
An apparent natural great pond with no public access.

East Bells Neck Pond (Road) (CC-38) 30 Acres
An apparent natural great pond with no formal public access.

8. Harwich (continued)
- Oliver Pond (Kenney's, Hawks Nest) (CC-38) 12 Acres
- An apparent natural great pond. No formal public access has been provided.
- Robbins Pond #7-1-126-3 (CC-38) 28 Acres
- An enlarged apparent great pond with no public access. The dam and flowage rights are owned by R. Gallagher.
- Sand Pond #7-1-126-2 (CC-38) 21 Acres
- An enlarged apparent great pond with no formal public access. The dam and flowage rights are owned by R. L. Thacher.
- Skinequit Pond (CC-38) 15 Acres
- A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided to these public waters.
- Hawks Nest Pond (Walkers) (CC-38) 30 Acres
- An apparent natural great pond for which no public access has been provided.
9. Mashpee
- Ashumet Pond (CC-40) 214 Acres
- A natural great pond surveyed by the Division of Waterways (DEQE) adjacent to the Crane Wildlife Management Area and Audubon land. It is stocked by the Massachusetts Division of Fisheries and Wildlife. Access has been established by the Public Access Board.
- Jim Pond (CC-40) 11 Acres
- An apparent natural great pond with no formal public access.
- Johns Pond #7-1-172-4 (CC-40) 317 Acres
- An enlarged great pond identified by the Division of Waterways (DEQE). Public access has been developed by the Massachusetts Public Access Board. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife. The dam and flowage rights are owned by A. D. Makepeace Company.

8. Harwich (continued)
- Briggs Pond (Joseph's Pond) (CC-38) 19 Acres
- An apparent natural great pond for which no public access has been provided.
- Bucks Pond (Walker's Pond) (CC-38) 29 Acres
- A natural great pond surveyed by the Division of Waterways (DEQE). Formal public access to these public waters has been provided by the Division of Waterways (DEQE).
- Cornelius Pond (Briar) (CC-38) 11 Acres
- An apparent natural great pond with no formal public access.
- Elldridges Pond (Walker's Pond) (CC-38) 25 Acres
- An apparent natural great pond for which no formal public access has been provided.
- Flax Pond (CC-38) 15 Acres
- An apparent natural great pond with no formal public access.
- Grass Pond (CC-38) 46 Acres
- An apparent natural great pond with no formal public access.
- Grassy Pond (CC-38) 11.5 Acres
- An apparent natural great pond with no public access.
- Herring River Pond Reservoir (North Harwich Reservoir) #7-1-126-6 (CC-38) 65 Acres
- A municipal artificial reservoir with no public access. The dam and flowage rights are owned by the Town of Harwich. The reservoir is used for cranberry bog irrigation.
- Hinckley Pond (Pleasant) #7-1-126-4 (CC-38) 171 Acres
- An enlarged great pond surveyed by the Division of Waterways (DEQE). There is no public access. The dam and flowage rights are owned by the Town of Harwich. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from the pond.
- Island Pond (CC-38) 17 Acres
- An apparent natural great pond for which no public access has been provided.

9. Mashpee (continued)

Mashpee and Wakely Ponds #7-1-172-1 (CC-39) 729 Acres

An enlarged great pond surveyed by the Division of Waterways (DEQE) with public recreational access developed by the Public Access Board. It is stocked by the Massachusetts Division of Fisheries and Wildlife. The dam and flowage rights are owned by the Town of Mashpee.

Moody Pond (CC-40) 18 Acres

An apparent natural great pond with no public access provided.

Santuit Pond #7-1-172-6, 7 (CC-39) 166 Acres

An enlarged great pond surveyed by the Division of Waterways (DEQE) with no formal public access. The dams and flowage rights are owned by A. D. Makepeace Company (N.E. side) and the Town of Mashpee (N.W. side). A license from the Division of Waterways (DEQE) exists to withdraw water from the pond.

10. Orleans

Baker Pond (CC-33) 32 Acres

A natural great pond surveyed by the Division of Waterways (DEQE) with informal access available through the Massachusetts Division of Fisheries and Wildlife land. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.

Cedar Pond (CC-37) 17 Acres

An apparent natural great pond. No formal access has been provided.

Crystal Lake (Fresh) (CC-37) 36 Acres

An apparent natural great pond with no public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife. A license from the Division of Waterways (DEQE) exists to withdraw water from the pond.

Pilgrim Lake (Dean Sparrows) (CC-37) 39 Acres

A natural great pond designated by the Division of Waterways (DEQE) with no formal public access.

11. Provincetown

Clapps Pond (Clappers) (CC-36) 44 Acres

An apparent natural great pond with no public access.

11. Provincetown (continued)

Shank Painter Pond (CC-36) 15 Acres

An apparent natural great pond with no public access.

12. Sandwich

Goodspeed Cemetery Pond (CC-39) 11 Acres

An apparent natural great pond with no formal public access.

Hog Pond Upper (CC-39) 11 Acres

An apparent natural great pond with informal access through the Massachusetts Division of Fisheries and Wildlife land.

Lawrence Pond (CC-39) 138 Acres

A natural great pond designated by the Division of Waterways (DEQE) with informal access through the Massachusetts Division of Fisheries and Wildlife land.

Peters Pond (CC-39) 127 Acres

A natural great pond identified by the Division of Waterways (DEQE) with public access for boating developed by the Public Access Board. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.

Pimlico Pond (CC-39) 14 Acres

An apparent natural great pond with no formal public access. It is presently stocked by the Massachusetts Division of Fisheries and Wildlife.

Shawnee Lake, Lower #7-1-261-1 (CC-32) 24 Acres

A municipally-owned artificial pond with no public access. The dam and flowage rights are owned by the Town of Sandwich.

Snake Pond (CC-40) 83 Acres

A natural great pond designated by the Division of Waterways (DEQE). There is no formal public access to the pond.

Spectacle Pond (CC-39) 91 Acres

A natural great pond surveyed by the Division of Waterways (DEQE), having no formal public access. It is stocked by the Massachusetts Division of Fisheries and Wildlife.

- 12 Sandwich (continued)
- Triangle Pond (CC-39) 77 Acres
- A natural great pond surveyed by the Division of Waterways (DEQE). There is no formal public access.
- Weeks Pond (CC-40) 15 Acres
- An apparent natural great pond with no formal public access.
13. Truro
- Great Pond (CC-35) 17 Acres
- An apparent natural great pond with no formal public access. It is presently stocked with fish by the Massachusetts Division of Fisheries and Wildlife.
- Horseleach Pond (CC-35) 24 Acres
- An apparent natural great pond with no public access.
- Ryder Pond (Johnson's, Aunt Mary Ryder) (CC-35) 18 Acres
- An apparent natural great pond. No public access has been provided.
- Slough Pond (CC-35) 28 Acres
- An apparent natural great pond with no formal public access.
14. Wellfleet
- Duck Pond (CC-35) 13 Acres
- An apparent natural great pond with no public access.
- Dyer Pond (CC-35) 10 Acres
- An apparent natural great pond with no public access.
- Great Pond (CC-35) 37 Acres
- An apparent natural great pond with no public access.
- Guil Pond (CC-35) 103 Acres
- An apparent natural great pond with no public access. It is presently stocked for fishing by the Massachusetts Division of Fisheries and Wildlife.
14. Wellfleet (continued)
- Herring Pond (CC-35) 19 Acres
- An apparent natural great pond having no public access.
- Higgins Pond (CC-35) 28 Acres
- An apparent natural great pond with no public access.
- Long Pond (CC-35) 34 Acres
- A natural great pond identified by the Division of Waterways (DEQE) with no formal public access.
- Williams Pond (CC-35) 10 Acres
- An apparent natural great pond with no formal public access.
15. Yarmouth
- Dennis Pond (CC-38) 50 Acres
- An apparent natural great pond with no public access.
- Flax Pond (CC-38) 10 Acres
- A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided.
- Greenough Pond (Taylors) (CC-38) 20 Acres
- An apparent natural great pond with no public access.
- Horse Pond (CC-38) 28 Acres
- An apparent natural great pond with no formal public access.
- Long Pond #7-1-351-1 (CC-38) 57 Acres
- An enlarged great pond identified by the Division of Waterways (DEQE) with no formal public access. The dam and flowage rights are owned by the Town of Yarmouth. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from the pond.
- Mill Pond (CC-38) 60 Acres
- An apparent natural great pond with no public access. One or more licenses from the Division of Waterways (DEQE) exist to withdraw water from the pond.

15. Yarmouth (continued)

Plashes Pond #7-1-351-2 (CC-38) 44 Acres
An apparent enlarged great pond with no formal public access.
The dam and flowage rights are owned by A. D. Makepeace Company.
Big Sandy Pond (CC-38) 16 Acres
An apparent natural great pond with no public access.
Little Sandy Pond (CC-38) 14 Acres
An apparent natural great pond with no public access.

MARTHA'S VINEYARD

ISLANDS STUDY AREA COMMUNITIES

1. Chilmark

Black Point Pond (IS-69) 80 Acres
An apparent natural great pond with no public access.
Chilmark Pond (IS-69) 278 Acres
A natural great pond identified by the Division of Waterways (DEQE). No public access has been provided.
Harlock Pond (IS-69) 14 Acres
An apparent natural great pond with no formal public access.
Nomans Land East Pond (IS-69) 14 Acres
An apparent natural great pond with no formal public access.
Nomans Land West Pond (IS-69) 12 Acres
An apparent natural great pond with no public access.
Quenames Cove (IS-69) 17 Acres
An apparent natural great pond with no public access.
Squibnocket Pond (IS-69) 554 Acres
A natural great pond designated by the Division of Waterways (DEQE) with no formal public access.

1. Chilmark (continued)

Squibnocket Ridge Pond (IS-69) 13 Acres
An apparent natural great pond with no public access.
Edgartown
Edgartown Great Pond (IS-69) 1,157 Acres
A natural great pond designated by the Division of Waterways (DEQE) with no formal public access.

2. Edgartown

Jobs Neck Pond (IS-69) 68 Acres
An apparent natural great pond with no public access.
Jobs Neck East Pond (IS-69) 17 Acres
An apparent natural great pond with no formal public access.

Oyster Pond (IS-69) 207 Acres
An apparent natural great pond with no public access.
Paqua Pond (IS-69) 14 Acres
An apparent natural great pond with no public access.
Trapps Pond (IS-69) 45 Acres
An apparent natural great pond with no public access.

3. Gosnold

Gosnold Pond (IS-69) 41 Acres
An apparent natural great pond with no public access.
Quicks Hole Pond (IS-69) 82 Acres
An apparent natural great pond with no formal public access.
South Bluff Road Pond (IS-69) 10 Acres
An apparent natural great pond with no public access.
Westend Pond (IS-69) 65 Acres
An apparent natural great pond with no formal public access.

4. Oak Bluffs

Crystal Lake (IS-69) 12 Acres

An apparent natural great pond with no formal public access.

Farm Pond (IS-69) 33 Acres

An apparent natural great pond with no public access.

5. West Tisbury

Black Water Pond (IS-69) 12 Acres

An apparent natural great pond with no formal public access.

Doggetts Pond (IS-69) 10 Acres

An apparent natural great pond with no formal public access.

Homers Pond (IS-69) 43 Acres

An apparent natural great pond with no public access.

James Pond (IS-69) 37 Acres

A natural great pond designated by the Division of Waterways (DEQE). No formal public access has been provided.

Long Cove (IS-69) 83 Acres

An apparent natural great pond with no formal public access.

Old House Pond (IS-69) 11 Acres

An apparent natural great pond with no public access.

Seths Pond (IS-69) 12 Acres

A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been provided.

Watcha Pond (IS-69) 68 Acres

An apparent natural great pond with no formal public access.

NANTUCKET ISLAND

6. Nantucket

Copaun Pond (IS-70) 18 Acres

An apparent natural great pond with no public access.

Coskata Pond (IS-70) 44 Acres

An apparent natural great pond with no formal public access available.

Gibbs Pond (IS-70) 34 Acres

An apparent natural great pond with no formal public access.

Head of Hummock Pond (IS-70) 17 Acres

An apparent natural great pond with no public access.

Hummock Pond (IS-70) 220 Acres

A natural great pond identified by the Division of Waterways (DEQE). No formal public access has been obtained.

Long Pond (IS-70) 70 Acres

An apparent natural great pond with no public access.

Miacomet Pond (IS-70) 34 Acres

An apparent natural great pond with no public access.

North Headlong Pond (IS-70) 55 Acres

An apparent natural great pond with no public access.

Seschacha Pond (IS-70) 276 Acres

A natural great pond surveyed by the Division of Waterways (DEQE). No formal public access has been obtained.

Tom Nevers Pond (IS-70) 13 Acres

An apparent natural great pond with no formal public access.

SOUTH SHORE STUDY AREA COMMUNITIES

1. Braintree

Old Quincy Reservoir (Reservoir Pond)
#6-11-40-7* (SS-23)+ 45 Acres

An artificial municipally-owned reservoir used for recreation. The dam and flowage rights are with the City of Quincy. No formal public access exists.

Sunset Lake (Little Pond) #6-11-40-6 (SS-24) 57 Acres

An apparent enlarged great pond. A municipal boat ramp on town property affords local recreational access, but there is no formal public access. The dam and flowage rights are with the Town of Braintree.

Smelt Brook Pond (SS-25) 20 Acres

A recently completed artificial pond which was a joint federal (Corps of Engineers) and local government flood control/recreation project. Public access is afforded through Broadmeadow Park, town recreation land. The dam and flowage rights are with the Weymouth-Braintree Recreation Conservation District.

Great Pond #6-11-40-4 (SS-24) 180 Acres

An apparent enlarged great pond serving as a local water supply reservoir, currently closed to any recreation. The dam and flowage rights are with the Braintree-Randolph Water Department.

Upper Reservoir #6-11-40-4 (SS-24) 165 Acres

(See Upper Reservoir, Randolph)

2. Cohasset

Lily Pond (SS-26) 46 Acres

An apparent natural great pond which is presently being enlarged to make a 155-acre town water supply reservoir. The water supply project, designated as the Aaron River Reservoir, has a scheduled completion date of December, 1977. No recreational use is contemplated for this reservoir.

3. Duxbury

Island Creek Pond (SS-28) 45 Acres

A natural great pond designated by the Division of Waterways (DEQE). Recreational use is aided by formal public access acquired by the Massachusetts Division of Waterways (DEQE). The Division of Waterways (DEQE) has issued one or more licenses to withdraw irrigation water from this pond.

Lower Chandler Pond (SS-29) 35 Acres
(See Pembroke)

Garside (South River) Reservoir #7-12-82-5 (SS-28) 37 Acres

An artificial municipally-owned reservoir used for irrigation with informal access over town land for fishing and boating. The dam and flowage rights are with the town.

4. Hanover

Factory Pond #7-12-123-2 (SS-27) 55 Acres

An artificial pond (partly in Hanson) recently acquired by Plymouth County and subsequently turned over to the Hanover and Hanson Conservation Commissions for control and management. Recreational access can be obtained over town land. The dam and flowage rights are with the local Conservation Commissions.

5. Hanson

Factory Pond #7-12-123-2 (SS-27) 55 Acres

(See Factory Pond, Hanover)

6. Hingham

Accord Pond #7-12-131-5 (SS-26) 95 Acres

An apparent enlarged great pond (also in Norwell and Rockland) is used for a local water supply. The reservoir is currently open to shore fishing. The dam and flowage rights are with the Hingham Water Company. No formal public access has been provided.

7. Holbrook

Lake Holbrook (SS-24) 40 Acres

An artificial municipally-owned reservoir used for recreation. The dam and flowage rights are with the Town of Holbrook. No formal public access exists.

8. Hull
No lakes, ponds, or reservoirs that meet criteria.
9. Kingston
Crossman's Pond (SS-29) 15 Acres
A natural great pond designated by the Division of Waterways (DEQE). Commercial recreation use is afforded by a small boat rental concern. The Division of Waterways (DEQE) has issued a license to withdraw irrigation water from this pond. No formal public access exists.
Lorings Bog Pond (Golden Reservoir) #7-12-82-20 (SS-29) 15 Acres
An artificial municipally-owned reservoir used for irrigation with informal public access at present over town land for recreational use. The dam and flowage rights are with the town.
Indian Pond (SS-29) 66 Acres
An apparent great pond. There is informal public access for recreational use at present across town-owned land. The Division of Waterways (DEQE) has issued one or more licenses for the withdrawal of irrigation water from this pond.
Muddy Pond (Lake Providence) (SS-29) 41 Acres
A natural great pond designated by the Division of Waterways (DEQE). There is no public access. The Division of Waterways (DEQE) has issued a license for irrigation water withdrawal from the pond.
Silver Lake (SS-27) 640 Acres
(See Silver Lake, Pembroke)
Smelt Pond (SS-29) 44 Acres
A natural great pond designated by the Division of Waterways (DEQE). Limited public recreational use takes place on this pond. The Division of Waterways (DEQE) has issued one or more licenses for irrigation water withdrawal from this pond. No formal public access exists.
10. Marshfield
No lakes, ponds, or reservoirs meet criteria.
11. Norwell
Accord Pond #7-12-131-5 (SS-26) 95 Acres
(See Accord Pond, Hingham)
Jacobs Pond #7-12-219-4 (SS-27) 55 Acres
A municipally-owned artificial reservoir with limited recreational use due to poor water quality. The dam and flowage rights are with the town of Norwell.
Pembroke
Furnace Pond (SS-27) 112 Acres
A natural great pond designated by the Division of Waterways (DEQE). The pond, currently open to public recreational use across town land, is used as a water supply adjunct for the Town of Brockton. There is no formal public access.
Hobomock Pond (SS-27) 15 Acres
An apparent natural great pond. There is informal access over town land to a beach area for residents. A private recreation camp also can be found on this pond. There is no formal public access.
Oldham Pond (SS-27) 235 Acres
A natural great pond designated by the Division of Waterways (DEQE). There is informal access over town land to a beach area for town residents. One or more licenses have been issued by the Division of Waterways (DEQE) for irrigation water withdrawal from this pond. There is no formal public access.
Great Sandy Bottom Pond (SS-27) 109 Acres
A natural great pond designated by the Division of Waterways (DEQE). The pond serves as water supply for the Towns of Rockland and Abington and presently is restricted to any recreational use.
Little Sandy Bottom Pond (SS-27) 61 Acres
A natural great pond designated by the Division of Waterways (DEQE). One or more licenses have been issued by the Division of Waterways (DEQE) to withdraw irrigation water from this pond. Informal public access can be gained at present across town-owned land, but no formal public access is available.
12. Pembroke

12. Pembroke (continued)

Silver Lake (SS-27)

640 Acres

An apparent natural great pond. This large pond, partly in the Towns of Kingston, Halifax, and Plympton serves as a water supply for the City of Brockton and is closed to any recreational use.

Stetson Pond (TA-49)

93 Acres

A natural great pond designated by the Division of Waterways (DEQE). A boat landing on town land provides local access for recreational use. The Division of Waterways (DEQE) has issued one or more licenses to withdraw irrigation water from this pond. There is no formal public access.

13. Plymouth

Abner Pond (BB-41)

10 Acres

A natural great pond designated by the Division of Waterways (DEQE). There is limited public use due to the presence of a Boy Scout camp on this pond. However, no formal public access exists.

Bartlett Pond (SS-30)

32 Acres

A natural great pond designated by the Division of Waterways (DEQE). Recreational fishing is presently conducted through informal access over town land to this pond. No formal access has been provided.

Darby Pond #7-12-239-32 (BB-42)

30 Acres

An apparent enlarged great pond. The pond is used for recreation and irrigation. One or more licenses have been issued by the Division of Waterways (DEQE) to withdraw water. Because two separately owned dams are found on this pond, the flowage rights are shared between the Boy Scouts and Robert Alberghini. No public access exists.

Deer Pond (BB-41)

10.2 Acres

An apparent natural great pond with no public access.

Doctors Pond (BB-41)

2 Acres

A small natural pond which is part of Myles Standish State Park under the control of the DEM. The pond is used for fishing. Informal public access is available across this state land.

13. Plymouth (continued)

Elbow Pond (SS-31)

16 Acres

An apparent natural great pond. A Boy Scout camp controls much of the recreational access to this pond. The Division of Waterways (DEQE) has issued a license to withdraw irrigation water from this pond. There is no formal public access.

Ellis Pond (BB-43)

11 Acres

A natural great pond designated by the Division of Waterways (DEQE). There is no formal public access. A private campground controls much of the shoreline.

Ezekial Pond (BB-41)

36 Acres

An apparent natural great pond. There is a small private beach area for surrounding cottage residents. A small road-adjacent boat ramp provides some boating access for the public. No formal public access exists.

Fawn Pond #7-12-239-45 (BB-41)

45 Acres

An enlarged great pond designated by the Division of Waterways (DEQE). A Boy Scout camp owns much of the shoreland controlling access. The Division of Waterways (DEQE) has issued one or more licenses for irrigation water withdrawal. The dam and flowage rights are with A. D. Makepeace Company. No formal public access exists.

Fearing Pond (BB-41)

24 Acres

An apparent natural great pond is within the Myles Standish State Park under the control of the DEM. Informal public access for recreation is available across the state land.

Five Mile Pond #7-12-239-49 (BB-41)

29 Acres

An enlarged great pond designated by the Division of Waterways (DEQE). There is a Boy Scout camp on the pond as well as a boat ramp presently providing informal public access. The Division of Waterways (DEQE) has issued a license for irrigation water withdrawal. The dam and flowage rights are with the Boy Scouts of America. No formal public access exists.

Fresh Pond #7-12-239-26 (SS-30)

62 Acres

An apparent enlarged great pond. A town beach area and boat landing have been developed. The Division of Waterways (DEQE) has issued a license for irrigation water withdrawal. The dam and flowage rights are with the United Cape Cod Cranberry Company. No formal public access has been provided.

13. Plymouth (continued)

Gallows Pond (SS-30)

43 Acres

A natural great pond designated by the Division of Waterways (DEQE). Two Girl Scout camps are on this pond. There is no formal public access to these public waters.

Big West Pond (SS-30)

40 Acres

An apparent natural great pond. Informal public recreational access can be gained through state land, as this pond is adjacent to Myles Standish State Park.

Little West Pond (SS-30)

25 Acres

An apparent natural great pond. Informal public access for recreation is afforded through state land, as this pond is adjacent to the Myles Standish State Park.

Grassy West Pond (SS-30)

20 Acres

An apparent natural great pond. Informal public recreational access is afforded across state land. This pond is adjacent to the Myles Standish State Park.

Gunners' Exchange Pond (SS-30)

29 Acres

An apparent natural great pond in the Myles Standish State Park under the control of the DEM. Fishing is the principal recreational use of this pond. The Division of Waterways (DEQE) has issued a license for the withdrawal of irrigation water from this pond. Informal public access can be gained over state land.

Hoyt's Pond (SS-30)

16 Acres

An apparent natural great pond in the Myles Standish State Park under the control of the DEM. Fishing is the principal recreational use of this pond. The Division of Waterways (DEQE) has issued a license for the withdrawal of irrigation water from this pond. Informal public access is available over state land.

Halfway Pond (BB-41)

232 Acres

An apparent natural great pond. The shoreline of this pond is presently posted. Some fishing takes place. The Division of Waterways (DEQE) has issued a license for the withdrawal of irrigation water from this pond. No formal public access has been obtained.

13. Plymouth (continued)

Hedges Pond (SS-31)

26 Acres

An apparent natural great pond. Recreational access to this pond is quite limited due to the presence of a private recreation camp. No formal public access has been obtained.

Great Herring Pond (SS-31)

410 Acres

An enlarged great pond designated by the Division of Waterways (DEQE). Formal public access for boating has been obtained and developed by the Massachusetts Public Access Board on the Bourne portion of the pond. One or more licenses exist to withdraw irrigation water from the pond.

Little Herring Pond (SS-31)

90 Acres

An enlarged great pond designated by the Division of Waterways (DEQE). The Division of Waterways (DEQE) has acquired formal public access allowing for recreational use of this pond.

Island Pond (SS-30)

12 Acres

An apparent natural great pond. This pond is used for fishing, although no formal public access is provided.

Great Island Pond #7-12-239-27 (SS-30)

77 Acres

An apparent enlarged natural great pond used for bog irrigation and recreation. There is a small beach area on this pond. The Division of Waterways (DEQE) has issued one or more licenses for the withdrawal of irrigation water. The dam and flowage rights are with George R. Briggs.

Little Island Pond #7-12-239-24 (SS-30)

30 Acres

An enlarged great pond designated by the Division of Waterways (DEQE). This Division has issued a license for irrigation water withdrawal. The pond shoreline is posted to any recreational use. The dam and flowage rights belong to George R. Briggs.

King's Pond (BB-43)

25 Acres

A natural great pond designated by the Division of Waterways (DEQE). The pond is used for recreation as well as bog irrigation. The Division of Waterways (DEQE) has issued a license for water withdrawal. No formal public access has been obtained.

13. Plymouth (continued)

Little Pond (SS-30)

43 Acres

An apparent natural great pond. The Town of Plymouth has developed a fee use beach which is presently open to both town residents and the general public.

Long Pond (BB-41)

211 Acres

A natural great pond designated by the Division of Waterways (DEQE). Formal public access has been obtained and a boat ramp developed by the Massachusetts Public Access Board. One or more licenses exist at the Division of Waterways (DEQE) to withdraw water from the pond.

Little Long Pond (BB-41)

45 Acres

An apparent natural great pond. Formal public access for portable boats has been obtained at the south end of the pond by the Massachusetts Public Access Board. The Division of Waterways (DEQE) has issued one or more licenses to withdraw water.

New Long Pond (BB-41)

23 Acres

An apparent natural great pond within the Myles Standish State Park under the control of the DEM. This pond is used for all types of recreation. Informal access is gained over state land.

Lout Pond (SS-30)

18 Acres

An apparent natural great pond. The pond serves as a secondary town water supply for Plymouth. Fishing from shore and nonpower boats is presently permitted, but no formal public access has been obtained.

Micajah Pond (SS-30)

20 Acres

An apparent natural great pond. The pond is used for fishing and boating. No formal public access exists.

Morey's Hole Pond (SS-30)

20 Acres

An apparent natural great pond. The presence of a Boy Scout camp somewhat restricts public use and access. The Division of Waterways (DEQE) has issued a license for irrigation water withdrawal. No formal public access has been obtained.

13. Plymouth (continued)

Powder Horn Pond (SS-30)

10 Acres

An apparent natural great pond with limited recreational use. No formal public access has been obtained.

Rocky Pond #7-12-239-43 (BB-43)

20 Acres

An artificial pond used for experimentation on cranberry bog irrigation. Informal recreational access exists, however, through Myles Standish State Park. The dam and flowage rights belong to the University of Massachusetts.

Big Rocky Pond (BB-41)

20 Acres

An apparent natural great pond. Recreational access is quite limited due to the presence of surrounding private cottages.

Little Rocky Pond (BB-41)

11 Acres

An apparent natural great pond. Access and water quality are poor.

Round Pond (BB-41)

22 Acres

An apparent natural great pond. Much of the surrounding land is privately-owned restricting recreational access.

Big Sandy Pond (BB-41)

135 Acres

An apparent natural great pond. Recreational access is afforded through a state-built boat ramp.

Little Sandy Pond (BB-41)

29 Acres

A natural great pond designated by the Division of Waterways (DEQE). There is a developed beach area and informal recreational access to this pond. The Division of Waterways (DEQE) has issued a license for irrigation water withdrawal from this pond.

Savery Pond (SS-31)

32 Acres

An apparent natural great pond. The presence of many surrounding private cottages makes the pond quite inaccessible to public use.

Great South Pond (SS-30)

292 Acres

An apparent natural great pond. This pond, serving as a secondary town water supply, is closed to recreation except for fishing by permit for town residents only. The Division of Waterways (DEQE) has issued one or more licenses for irrigation water withdrawal.

13. Plymouth (continued)

Little South Pond (SS-30) 62 Acres

An apparent natural great pond. The pond serves as a primary town water supply and, as such, is closed to any recreational use.

Three Cornered Pond (BB-41) 14 Acres
A natural pond, part of the Myles Standish State Park under the control of the DEM. A small access ramp allows for canoeing and fishing. Informal access is gained over state land.

Triangle Pond (SS-31) 10 Acres
An apparent natural great pond. Recreational access is quite limited due to surrounding private cottages.

South Triangle Pond (SS-30) 19 Acres
An apparent natural great pond with very limited recreational use. No formal public access has been obtained.

Wall Pond (BB-41) 12 Acres
This is an apparent natural great pond. At present, informal access for fishing is available as a small beach area is for local residents. There is no formal public access.

Waites Pond (BB-41) 33 Acres
This is an apparent natural great pond. Fishing and boating use occurs on this pond. The Division of Waterways (DEQE) has issued a license for irrigation water withdrawal. No formal public access has been obtained.

Widgeon Pond (BB-43) 24 Acres
This apparent natural great pond is part of the Myles Standish State Park under the control of DEM. Recreational access is difficult, due to the presence of surrounding leased cottages, but informal public access can be obtained across the state land.

14. Plympton
Silver Lake (SS-27) 640 Acres
(See Silver Lake, Pembroke)

15. Quincy

No lakes, ponds, or reservoirs meet criteria.

16. Randolph

Upper Reservoir #6-11-40-4 (SS-24) 165 Acres

An artificial reservoir serving as a local water supply. The reservoir is currently closed to recreation. The dam and flowage rights are with the Town of Braintree.

17. Rockland

Accord Pond #7-12-131-5 (SS-26) 95 Acres

(See Accord Pond, Hingham)

Studley's Pond (Reeds Pond) #7-12-251-1 (SS-24) 26 Acres

An artificial municipally-owned pond used principally for local recreation. The pond is presently being dredged out to effectuate water quality improvement. The dam and flowage rights are with the Town of Rockland.

18. Scituate

Wagner's Meadow Reservoir #7-12-264-5 (SS-27) 80 Acres

An artificial municipally-owned reservoir used for water supply. The reservoir is essentially closed to recreation. The dam and flowage rights are with the Town of Scituate.

19. Weymouth

Weymouth Great Pond #6-11-336-2 (SS-26) 290 Acres

An apparent enlarged great pond. The pond is utilized as a local water supply. It is closed currently to public recreational use.

Whitmans Pond #6-11-336-3 (SS-26) 175 Acres

An enlarged great pond designated by the Division of Waterways (DEQE). The dam and flowage rights are with the Town of Weymouth. The pond serves as part of the town's water supply. It is open at present for public recreation. Access can be gained across town land off Route #53.

